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ARE LIGHTNING-RODS USELESS?

Some remarks made in these columns a few weeks ago have stirred our estimable contemporaries of the daily press to the writing of many words of voluminous discussion on the whole subject of lightning from all points of view. The Chicago *Tribune,* for example, thinks that if none of the existing devices for protection against lightning is available, the electrical experts should at once proceed to provide one. The Washington *Post* agrees with us that lightning is one of the least prolific causes of death but that it annually destroys much property. To all the various views of this subject thus far adduced, statistics are brought, but of course everybody knows that anything whatever may be proved by means of statistics, if one only takes time to do it.

The fact of the matter seems to be that lightning is very nearly harmless. Somewhere about 100 people are killed by it annually in the United States, out of a population of nearly eighty million; more are killed by the nails in their shoes or by falling of chimneys. The real trouble seems to be that thousands upon thousands of people are badly scared several times every Summer by the lightning, or rather by the thunder which accompanies it. Far be it from us to shake the faith of any timorous soul who believes the featherbed to be a haven of safety during a thunderstorm. The time-honored rules about sitting in draughts or near open windows or standing under trees are well worth observing, especially if they give the individual any additional sense of security and alleviate his mortal dread and distress. We can not see that any of the discussion has proved that the lightning-rod has been of the least use. At best this would be negative proof were it possible to produce it. As it stands, however, rural districts are the home of the lightning-rod and the place where lightning does nearly all its damage. We do not see many lightning-rods in cities nor do we hear much about the evil effects of lightning in them.

Out of the confusing mass of lightning lore, there has not yet come a clear or satisfactory explanation either of its action or its cause. The electrician must wait for better knowledge before he can design a perfectly satisfactory protection. In the absence of this he can only say that money spent in lightning-rods is generally wasted.

The business career of Mr. John M. Roach, who has just been elected president of the Union Traction Company, of Chicago, is one that contains a lesson, a moral and an inspiration for every young man. From a conductor on a horse car, in 1872, to the presidency, in 1900, of a street railway system comprising 500 miles of track, is so remarkable an achievement as to merit more than passing notice. The faithful and intelligent application, the dogged perseverance, the wit to seize the passing opportunity and the unswerving belief in his own destiny that bring to a man such well-merited reward, are worthy of the study and emulation of every American youth.

The annual convention of the Independent Telephone Association of the United States, which is called to meet at Cleveland, Ohio, on June 12, 13 and 14, promises to be of unusual importance and value to the independent telephone interests of the country. Since the last meeting of this association, which is the representative body of its kind, great progress has been made in independent telephony. Many excellent new toll-line systems have been built and combinations of existing lines effected. The affairs of the association are in competent hands, and with Judge Thomas as its presiding officer, there is no doubt that the sessions of the convention will be conducted in such a manner as to produce the utmost benefit to the delegates present.

IS ELECTRICITY IN ITS INFANCY?

It is hard for any of us who are intimately connected with electricity in its applications to realize how very young the subject is, and at the same time what tremendous development it has attained in the few years of its life. We look back to the first dawn of civilized history and see there the beginnings of civil, mining, mechanical and marine engineering. Four thousand years ago these arts had attained remarkable development and architecture had been carried to a point of high development. Indeed, with the progress of the ages they made little advance until the restless seventeenth century started the struggle for the development of mechanical power and their application to replace the labor of men and animals. The greatest product of the eighteenth century and probably the greatest production of the inventive faculty, so far as its value is concerned, was the steam engine. The effect of this machine upon all classes and degrees of engineering was simply marvelous. It made easy what had before been impossible, and put into the hands of engineers a means for carrying out the projects that would have been considered ridiculously impossible before its invention. The steamship and the railroad were merely the corollaries of this revolutionary invention. With the passage of time the pace of development grew, and the first half of the nineteenth century showed this acceleration in nearly all branches. The railroad, by enormously reducing time and expense of transit, brought closer together the scattered thought of the world. It made new problems of astonishing magnitude and solved old ones. Almost contemporary with it came the telegraph, and in twenty-five years this had linked together the principal centres of civilization of the world, the daring project of the Atlantic cable having been conceived and perfected. The real beginning of electrical engineering, by which is meant the application of accurate scientific knowledge to physical structures, was probably in connection with this cable. It is not easy to realize that it has taken only twenty-five years for the whole invention, exploitation, growth and development of the arts using heavy currents of electricity furnished by dynamo machines. Commercial electric lighting is little more than twenty years old. The electric railway is thirteen years old. Polyphase systems of transmission are about ten years old. The great electrochemical arts of the manufacture of aluminum, caustic, bleaching powder, etc., are for the most part younger than this. Still, to-day, electrical engineering, directly or indirectly, affects in some way the daily life of practically every human being in civilized countries.

While no one can more fully realize the silliness of the statement that "electricity is in its infancy," than the electrical engineer, yet this statement is not untrue if one applies it to electrical engineering applications. It seems to-day as if we knew very much about the theory of electrical action and about how to generate and apply electricity, but is it not true that no one can foresee to-day the growth of electrical applications in another decade? In the last quarter of a century these applications have utterly revolutionized the methods of lighting, of power transmission, of transportation in cities and to some extent elsewhere, and are steadily advancing in number and importance and with an accelerating speed. It would be a bold man, therefore, who would deny to-day the possibility that another quarter-century may see a more stupendous utilization of electrical methods.

It is in this direction that the electrical engineer must hope for the future of his craft. There probably will not be many more spectacular and revolutionary inventions such as the electric light and the telephone, but electricity has an enormous field yet to conquer. A sum of money equivalent to the national debt will probably be required in the next twenty-five years for the electrical equipment of all the main-line steam railroads in this country. Electric heating is still to have its opportunity. Power transmission methods and apparatus are being further perfected every day. Only a moderate perfection of the accumulator is needed to make the electromobile as great a factor in transportation as the trolley car is now. In every field there is the brightest outlook for the extension of the electrical industry.

The paper by Mr. W. L. Abbott, read at the recent electric light convention and reprinted on another page, is one of those admirable and sensible contributions to electrical literature that are of real use to central-station men. It concerns itself with the practical details of central-station operation and gives data of a kind calculated both to interest and instruct. It is exceedingly well worth reading.

The prosperity which is so widespread will certainly result in a great extension of electric lighting as the days grow longer. A good many people still think electric light is a sort of expensive luxury, only to be afforded when times are flush and money plentiful. These are just the sort of times that are ahead of us, and this Summer is the right time to get ready for the big extension and to go out and persuade people who are using gas to abandon their evil ways.

It is wonderful to contemplate the growth of electrical engineering schools in this country. Only about thirteen years ago the first course in electricity was established. To-day there are a dozen schools of electrical engineering of the highest class as regards equipment, instruction and personnel. Some of them possess really magnificent equipments and are turning out a very high class of graduates. No subject is taught at present under more perfect conditions, or with better facilities.

This is the time of year when the hum of the fan motor begins to be heard in the land, and when the trolley car starts in to run opposition to the roof-garden. A good many people (and the number is growing) take great delight in spending an hour or two of Summer evenings on the cool open cars, especially where these run into the country. Indeed, in New York, the number is so great that the cars are often uncomfortably crowded. Is there not a hint in this for the enterprising street railway manager? Why not special open cars with plenty of seat room, no glare of light to weary the eyes, taking no more passengers than they can seat, and charging an extra fare? In New York a hundred such cars could be kept busy every warm evening.

An American Electric Street Railway in Geneva, Switzerland.

An American company is just about to inaugurate a complete revolution of the traction and transportation system of the city of Geneva, Switzerland. As everybody knows, Geneva is a city of about 60,000 inhabitants, beautifully situated on the lake of the same name, and in the centre of an important and well-populated district. It lies almost immediately on the French border.

The original tramway lines of the city were operated by steam locomotives and horses. Before the American syndicate took hold of the situation there was about 45 miles of narrow-gauge track in the city and suburbs, and about 17 miles of medium gauge track belonging to another company. Options were obtained and the concordance of local capitalists secured, and finally the existing tramway lines were taken over at the price of $1,254,500. The company has also secured a charter from the local government under the name of Compagnie Genevoise des Tramways Electriques, and has acquired an additional concession permitting the construction of 15 kilometres (9½ miles) of road along the shore of the lake from Geneva to the village of Hermance, on the French border.

The company is generally known in Geneva as the American Company. It will have, when all of the track now projected is laid, about 97 miles of line, and will have expended upon the construction and equipment of its roads about $4,400,000.

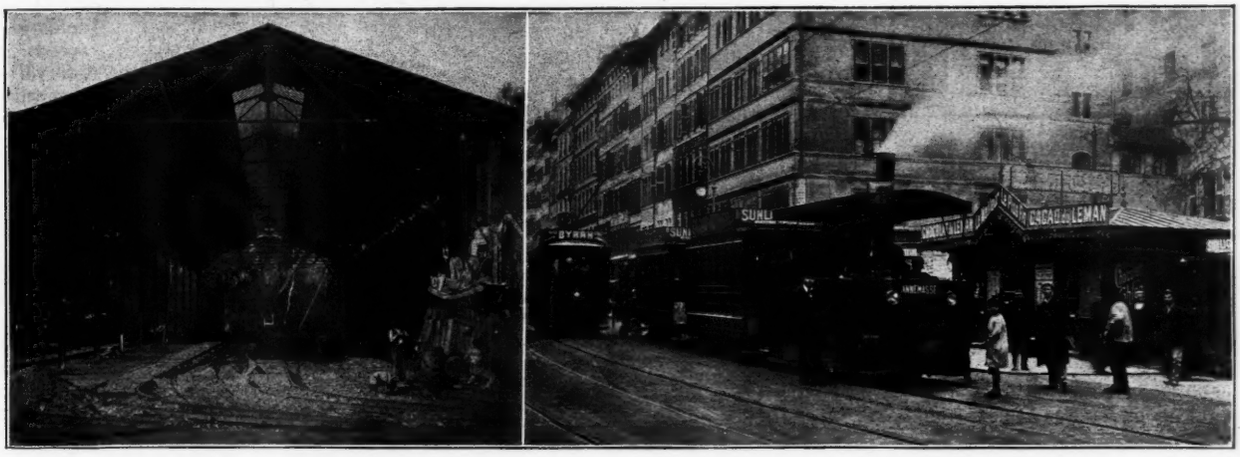
It is proposed and expected to have 50 kilometres of the new lines in operation by the end of the present year. The first line, that leading from the Hotel National to the Place Bel-Air, will be opened on the Fourth of July, when doubtless there will be many Americans in the city, and the occasion will be made one of general congratulation.

About 130 cars will be used, equipped with Westinghouse motors and apparatus. This is the only American-made machinery that will be used on the line except the rail-bonds, which are of the Brown-Edison plastic type. The cars are being constructed at Neuhausen, in Switzerland, as closely after the American model as the Swiss inspecting engineers will permit. For this purpose one car has been bought from the Brill Company, in Philadelphia, and shipped to Geneva by special permission.

The generating station is completely controlled by the municipal government of Geneva. It is a water-power station and is operated entirely as a municipal enterprise. An arrangement has been made between the railway company and the city to take current from this plant at the rate of 12 centimes (2.3 cents) for the first 1,800,000 kilowatt-hours used. After this amount the city will either furnish the power at 9 centimes (1.7 cents) a kilowatt-hour or else concede the company the right to generate its own power. It is believed by Mr. Stephen D. Field, the constructing engineer of the company, that he can generate power at a rate even less than the latter figure.

The tariff on street railway transportation in Geneva is only two cents per passenger for the first kilometre and one cent for each succeeding kilometre. It is stated by those who have studied the conditions of the transportation situation that the company can scarcely fail to achieve a profitable result from its enterprise. Five years are allowed for the construction and equipment of the line and the charter of the company extends over 65 years.

The two illustrations herewith show one of the new car barns in course of construction and also an interesting view at a transfer point where may be seen the old steam dummy tram cars and the new electric trolley cars.



CAR BARN IN COURSE OF CONSTRUCTION. TRANSFER STATION, SHOWING STEAM DUMMY AND TROLLEY CAR.

THE AMERICAN ELECTRIC STREET RAILWAY IN GENEVA, SWITZERLAND.

On Automobile Design.

TO THE EDITOR OF ELECTRICAL REVIEW:

Noting your editorial of recent date on the automobile of the future and noting your criticisms on the general design of horseless carriages, together with your comments on what would be considered a perfect appliance of this character, I beg to enclose for your criticism two prints of the "Luxor" automobile, recently designed by me. My aim has been to simplify and beautify the horseless carriage in such a manner that it will not have the appearance of a battering ram or traction engine, while, at the same time, I conceal from view all mechanism connected with the appliance and have succeeded in lowering the body to such an extent that a single step from the street will permit the occupant to reach the interior of the vehicle. The carriage body is carried on pneumatic springs which dispense with the need of pneumatic tires which are so difficult to keep in repair. The transmitting mechanism is so arranged that any speed of from one to 40 miles per hour can be had at the will of the operator by the use of a single lever, and the general construction is such that either storage batteries, hydro-carbon or steam power can be used for the propelling force. This carriage has been very favorably commented upon by a number of critics.

C. R. HARRIS.

Williamsport, Pa., May 24.

TELEPHONY OVER CABLES AND LONG-DISTANCE AIR LINES.

BY DR. M. I. PUPIN.

(Concluded from page 544.)

EXPERIMENTAL PART.

Description of the Experimental Cable—A so-called artificial cable possessing the above constants was constructed by me for the purpose of testing experimentally the mathematical theory. Previous experiments in this line will be found in the author's paper of March 22, 1899, cited above.

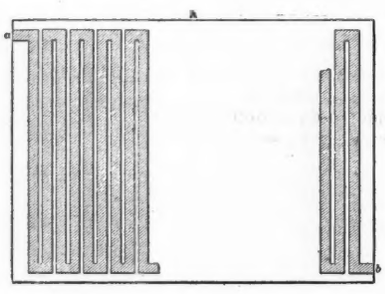


FIG. 6. SECTION OF ARTIFICIAL CABLE.

The cable has 250 sections One of these sections is represented in Fig. 6. It consists of a sheet *A* of paraffined paper. On each side of this sheet is a strip of tinfoil *a b*. The resistance of this strip is approximately 9.5 ohms. The capacity of the condenser formed by the two strips is .074 microfarads approximately. Two hundred and fifty sections of this kind connected in series represent a cable of 250 miles in length having a resistance of 9 ohms and a capacity of .074 microfarads per mile. That such is actually the case was verified experimentally, as will be shown presently. The sections can be connected in series by couplers to which these sections are attached. One of these couplers is represented in Fig. 8. A wooden strip *A B* has holes drilled through it at regular intervals. Through each hole passes a bolt *c*, the diameter of which is smaller than the diameter of the hole. Two hard rubber washers *a* and *b* hold the bolt in place and prevent it from touching the wood. A nut holds the brass plate *d* in place. Two consecutive brass plates *d d* can be conductively connected by the plug *e*. Screws, as indicated, connect the terminals *f f* of the condenser sections and of the coils *g g* to the brass plates. When the plugs are out then the consecutive sections of the cable are connected to each other by the inserted coils. The plugs being in the coils are short-circuited, and the consecutive sections of the cable are connected to each other directly by the plugs. In this case we have a uniform cable; in the former case we have a non-uniform cable of 250 miles length, with inductance coils inserted at each mile. The coils are wound as represented in Fig. 7. Two coils are wound on one spool, and are separated by a sheet of cardboard indicated by a black line in Fig. 7, which is one-sixty-fourth of an inch thick. The coil, when finished, is boiled in beeswax at a temperature of about 280 degrees Fahrenheit, in order to drive all the moisture out and insure good insulation. The dimensions of the coil are given in Fig. 7. Each coil had 580 turns of No. 20 wire B. & S. The average inductance of one of these coils is .030 henry, and the mutual induction .028 henry. Each coil, therefore, when connected into the line has an effective inductance of .058 henrys. This method of bringing the corresponding coils of the two sides of the cables into close relation by mutual induction is not necessary; it is a matter of convenience and economy.

The cable sections are divided in five groups of 50 each, and each of these groups is enclosed in a separate box. Each box represents, therefore, 50 miles of the cable. Fig. 9 is a reproduction from the photograph of one of these boxes. The box marked A is the cable box. On two opposite sides are five rows *ab*.... of binding posts, each row having 10 pairs. They are the terminals of the condenser sections. From these binding posts double cotton covered wires which have been boiled in beeswax lead to the row of brass plates indicated in the picture by letters.... The insulation per section was about 50 megohms.

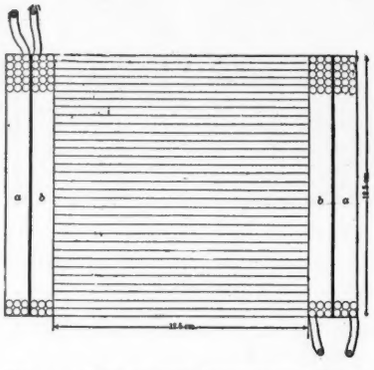


FIG. 7.—ONE OF THE INDUCTANCE COILS.

Determination of the Wave-length—1. To investigate the wave-length and the attenuation constant of a given frequency it was necessary to impress a simple harmonic electro-motive force upon the cable. This was obtained as follows: A small alternator of 30 poles running at a normal speed of 2,400 revolutions per minute was employed. It gives a complex harmonic electro-motive force in which the third and fifth harmonic are quite strong. At the normal speed the frequency of the fundamental was 600 periods per second. By transformation, as indicated in Fig. 10, the upper harmonics were weeded out by tuning. In this diagram A is the alternator. The secondary circuit D, E, F, G, contains a condenser F, and an auxiliary coil E. By adjusting the capacity of condenser F and the inductance of coil E, the impedance of this secondary circuit for the fundamental frequency can be reduced to a minimum, in which case the fundamental current in this circuit is by far predominant. Under these conditions the electro-motive force impressed upon the tertiary coil H, which connects to the line, is very nearly simple harmonic. This was verified by plotting experimentally the E. M. F. curve in the tertiary circuit. The point of resonance was detected by connecting the terminals of condenser F to a multicellular voltmeter K, and watching for the maximum rise of the potential While the observations which will be described presently were made, the reading of this voltmeter was continually watched. A change in it indicated a change in speed and impressed E. M. F. and the observations had to be suspended until the voltmeter returned to the same reading. Considering the variability of the electrical pressure in a university plant where every one of the many departments draws its current from the same source, it will be readily seen that these observations were somewhat trying.

The agreement between the calculated and the observed wave-length was extremely good for a frequency of 600, considering the inequality of the cable sections which necessitates taking for *L* and *C* average values. Following is a table of wave-lengths for other frequencies, giving both the observed and the calculated values:

FREQUENCY.	$\lambda_{obs.}$	$\lambda_{calc.}$
625	17	17.3
600	18.2	18.7
450	24	24.1
560	41.4	41.7
245	44	44.4
230	48	48.2

At the frequency of 600 periods per second the non-uniform cable has 18 coils per wave-length. At the lower frequencies the number of coils per wave-length is larger, and therefore the cable approximates then its corresponding uniform conductor even more closely than at the frequency of 600 periods per second. But the approximation at this higher frequency is already so close that no difference in the behavior of the cable at the various frequencies experimented with and given above could be detected experiment-

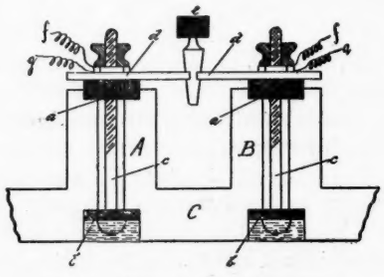


FIG. 8.—ONE OF THE COUPLERS.

ally. As far as the wave-length determination is concerned the agreement between theory and experiment is very satisfactory.

3. To determine the wave-length on the cable without the coils plugs (see *e*, Fig. 8) were put in 1, 2, 3. . . . The readings were taken as follows: The two-pole spring-

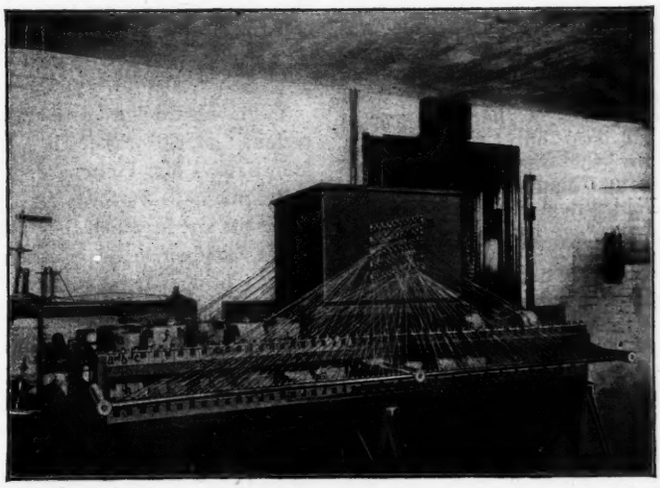


FIG. 9.—ONE OF THE BOXES OF THE ARTIFICIAL CABLE.

jack was inserted across a pair of plates, say 1. Then the short-circuiting plug was taken out and the deflection in the galvanometer noted. The number of reversals was counted as before, and from these the wave-length was estimated. The value of the wave-length thus determined for a frequency of 600 was 126. Its calculated value was 125. Thus the insertion of the coils reduces the speed of propagation to one-seventh of its original value since it shortens the wave-length to that extent.

The question now arises: What degree of accuracy can be claimed for this experimental determination of β? The expression for β contains the difference of quantities which are nearly equal. Now this difference is very near the limit of the errors of observation, the limit being quite considerable on account of several reasons. The chief reason is this. The condenser sections of the cable are far from uniform as a glance at the table will show. This lack of uniformity is due, first to the varying thickness of the tinfoil which makes the resistance vary from

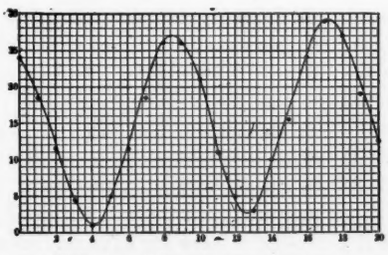


FIG. 11.—WAVE FORM CURVES

section to section. Secondly, the sections are heated before compression is applied to them. This heating is of course not quite uniform, hence the amount of paraffin driven out by the applied pressure is different in different sections. Hence, the variation of capacity. The result is that the speed of propagation is different in different sections. The difference may amount to as much as 20 per cent. Hence, the wave-length will change considerably from point to point of the cable. This will be observed in the curves of Fig. 11 and Fig. 12. Thus, in Fig. 11, the first quarter wave-length is four miles long, the second quarter wave-length is 4.5 miles and the average is 4.25. The same variation will be observed in curve of Fig. 12. It is evident, therefore, that the method

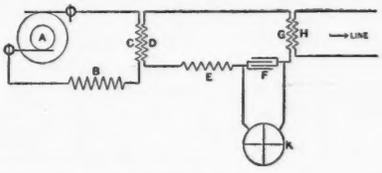


FIG. 10.—METHOD OF CONNECTING DYNAMO AND ARTIFICIAL LINE.

described above for taking readings at the various points of the cable will not give readings which are strictly proportional to the current at the point under consideration. Taking all these things into consideration, it is evident that this method just pointed out for determining

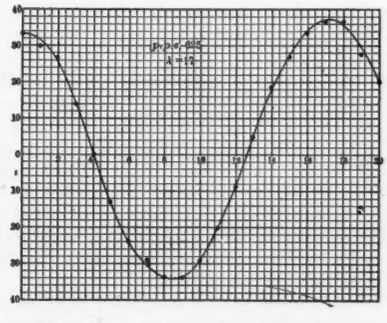


FIG. 12.—WAVE FORM CURVES.

experimentally the attenuation constant is not strictly applicable to our cable.

Second method—Another method will be described now which determines the attenuation constant not from the one-half wave-length only, near the middle of the line, but takes all the waves corresponding to a long length of the line into consideration. The wave-length determined by a similar experimental method agreed so much better with the theory for the very reason that the method employed gave the average wave-length and not the wave-length at any particular point of the cable.

Although the curves of Figs. 11 and 12 do not enable us to calculate β accurately they are still of considerable importance. *First*, they show that the cable, though it has a large resistance, possesses, nevertheless, a small attenuation constant. This is particularly well shown in the curve of Fig. 12. This curve represents the mean square of current curve at the various coils. The readings were obtained in this case by dispensing with the sliding contact arrangement and putting in place of *E* an electro-dynamometer. This mean square curve represents a very near approach to the stationary wave form, which shows that the attenuation is extremely small. *Secondly*, the smoothness of the curve shows that the non-uniform cable acts, even at the frequency of 625, just like a uniform cable. This, in fact, was the principal aim of this experimental research.

The calculated value of β as given above is .0141. Experiment and theory agree quite satisfactorily. *The equivalence between the non-uniform cable and its corresponding uniform conductor has therefore been established experimentally.*

INTERNAL REFLECTION OF ELECTRICAL WAVES IN A NON-UNIFORM CABLE.

It remains to be shown now that when the distribution of the inductance coils over the cable does not render the cable approximately equivalent to its corresponding uniform conductor, then there will be serious internal reflections which will diminish the efficiency of wave transmission.

For this purpose the inductance coils were connected in groups of ten; one of these groups was inserted into the cable every ten miles, so that the total inductance of the cable was now the same as before. A simple harmonic electro-motive force of 260 periods per second was im-

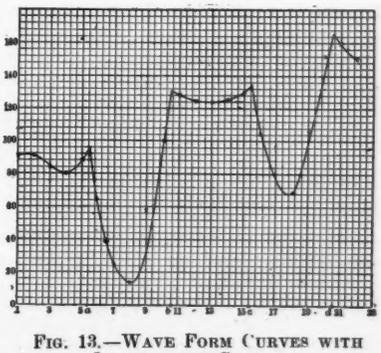


FIG. 13.—WAVE FORM CURVES WITH INDUCTANCES GROUPED.

pressed upon the cable. The wave-length of a wave of this frequency on the corresponding uniform conductor was found to be 41.4 miles apart at a distance which is equal to about one-quarter of the wave-length on the corresponding uniform conductors. The degree of equivalence be-

tween this non-uniform cable and its corresponding uniform conductor is the same as the degree of equivalence between sine $\pi/4$ and $\pi/4$; that is to say, the resemblance between the two is small.

Experiment—The curve of mean current value was obtained in the same manner as the curves of Figs. 11 and 12, except in this case the movable brush was shifted until the galvanometer showed the maximum deflections at every reading. These readings were plotted as ordinates of curve Fig. 13. Points *a b c d* on the axis of abscissæ mark the positions of the groups of inductance coils. The effect of reflections is shown in a very marked manner by the sharp corners and strong depressions. The sharp corners coincide, of course, with the positions of the coils. The rapid rise of the minima points show strong attenuation. To compare the attenuation in this case with the attenuation which exists where the coils are distributed one per mile it is only necessary to obtain from curve 13 the curve of mean square of current and compare it to curve of Fig. 12. Draw then a straight line through two consecutive minima and compare the slope of this line in curve 12 to that of curve 13. It will be found that the slope in this latter case is very much more rapid, and, therefore, the attenuation is very much more powerful; and it should be remembered that in curve 13 we have the attenuation which is accompanying a frequency of 260 periods per second. With a frequency of 600 periods per seconds (the frequency of Fig. 12) the attenuation would be even more powerful. I intend to continue this particular part of the research in the very near future.

Telephony over the non-uniform cable—These experimental results leave no doubt as to the correctness of the prediction which the mathematical theory of Part II makes with regard to telephony over non-uniform cables. Actual experimental tests with transmitters and receivers which were kindly put at my disposal by the New York Telephone Company, for which I feel very grateful to them, verified these prediction completely. Telephonic communication over the whole of the cable was carried on with perfect ease. Both the volume and the articulation of the transmitted sound were all that could be desired. If, however, the inductance coils were cut out and the cable used as a uniform cable, then the transmission was good up to 50 miles, fair up to 75 miles, impracticable at 100 miles, impossible at distances over 112 miles. Increased distance interferes with the transmission over the uniform cable, not only on account of the diminished volume of the sound transmitted, but also on account of the rapid loss of articulation. This manifests itself at first as an apparent lowering of the pitch of the voice just as the theory demands it. My assistant's voice is of an ordinary pitch, if anything a little above the pitch of the average man's voice. When it was transmitted over 75 miles of the uniform cable (that is, the coils being disconnected from it) it sounded like a strong baritone. Over a distance of 100 miles it became so "drummy," (this is an expression borrowed from telephone engineers) that it was difficult to understand it, unless nothing but ordinary conversation was carried on and then very slowly, and the speaker had to put his mouth as close to the transmitter as possible and speak out as if he were addressing a big audience. At distances over 112 miles nothing but the lowest notes of the voice could be heard; the articulation was entirely gone. When the coils were all in, then no drumminess in the voice was noticed, and the conversation could be carried on as rapidly as one chose to do. I understand that in long-distance work three galvanic cells of the same type of which I had two only were formerly employed by the American Telegraph and Telephone Company when they employed the old system of transmission.

Effect of internal reflections upon telephonic transmission—The effect of internal reflections is illustrated even more strikingly by telephonic transmission than it is by the exploration of the simple harmonic wave as represented in Fig. 13. The same distribution of coils was used for telephonic transmission as described above in connection with the internal reflection experiments. A distance of 100 miles of the cable was employed. Telephonic transmission over this distance was absolutely impossible, although the lowest note in the voice was transmitted quite vigorously, and sounded like the muffled beating of a big drum. Another distribution of the coils was now tried. The coils were divided into groups of five, and these groups were put into the cable at points five miles apart. Transmission over a distance of 100 miles becomes intelligible, though with much difficulty; but it was not as good as over the cable without the coils. The drumminess was even more excessive in the former case than in the latter. One had to put his mouth very close to the transmitter, speak very slowly, very loud, and about very ordinary things, otherwise the meaning of the transmitted intelligence would not be caught at all. But if the same distance of cable was employed with the inductance coils placed one mile apart as the mathematical theory suggests then the voice of the sender sounded just as if he stood right before the receiving operator. It was not necessary to stand near the transmitter at all, in order to be heard at the other end. There was no difficulty in making the receiving operator understand even if the transmitting operator stood anywhere in the room at a distance of 20 feet or more from the transmitting instrument. The effect of the inductance coils properly distributed over the cable upon the efficiency of transmission astonishes even one like myself who have now worked for years upon and made myself perfectly familiar with this most fascinating problem of electro-mechanics.

The inductance coils which I have so far described contain no iron; coils with iron cores to be used for this purpose will have, of course, to be constructed in a perfectly definite way to work satisfactorily. I expect to bring this matter before the institute at some future time. Suffice it to state now that such coils would be required in the construction of non-uniform submarine and underground telephone cables on account of the much smaller volume per unit of inductance. For long-distance air lines inductance coils without iron cores would be in many respects preferable.

In conclusion I wish to thank my assistant Mr. Cushman, and my students, Mr. Frank and Mr. Koscherak, for the very faithful and persevering way in which they have assisted me throughout these experimental researches.

Ultra-Violet Rays.

With regard to cathode rays and certain other rays, it is already known, says Mr. P. Lenard, in the *Electrotechnische Zeitschrift,* that they make the air, in which they diffuse themselves, conductive of electricity, by the oxygen being partially transformed into ozone and the formation of the nuclei of condensed moisture so effected. The author points out that a ray bearing close relationship to visible light is also capable of producing similar effects—namely, the ultra-violet rays of short wave-length (*n* equal from 0.00014 millimetre to 0.00019 millimetre), to which V. Schumann first called attention in the year 1893. These rays are subject to an extraordinarily high degree of absorption in almost all mediums, including the atmosphere, says the London *Electrical Engineer,* while isolated bodies only, such as fluospar, gypsum, or hydrogen gas, were discovered to afford a good passage to the rays. Convenient as sources of such ultra-violet rays are a spark-gap of an induction machine composed of aluminum wires and an electric arc, particularly if the positive carbon is substituted by a rod of aluminum, and also sunlight, but this only in the upper strata of the earth's atmosphere *i.e.,* upon high mountains. The author shows the process of the formation of the nuclei of fog by reflecting the light from electrical discharges upon a jet of steam through a window of quartz placed within a shield of zinc connected to earth. Upon setting up the discharges, the hitherto misty and undefined form of the jet became cloudy and better defined, while its usually uniform gray tint was succeeded by glistening colors or a brilliant white. This is an indication that the rays created nuclei of condensed particles of moisture. It was not found necessary that the jet of steam should be placed direct in the beam of light proceeding from the window so long as it was situated near the window. Conductors charged with electricity are discharged when subjected to the influence of ultra-violet rays of short wave-length, and in this case positive charges are as rapidly lost as negative charges, the nature of the conductor exerting no influence upon the result.

SERIES ENCLOSED ALTERNATING ARC LIGHTING FOR STREET LIGHTING SERVICE.

BY PROFESSOR W. L. ROBB.

(*Concluded from page 555.*)

The following brief comparison of the series enclosed alternating-current arc lighting from constant-current transformers with the other systems of series enclosed arc lighting suggested in the earlier part of the paper, may prove interesting. In making the comparison between the different systems, I have assumed, and believe it to be true, that equally satisfactory results in street lighting can be obtained from the 6.6-ampere enclosed direct current, and the 7.5-ampere enclosed alternating-current arc lamps. The comparison is confined to these two lamps under full load conditions, as in series street lighting this is the usual working condition.

First—Comparison of system using direct-current arc dynamos, belted from a line shaft driven by motor.

Actual experience in the Hartford case showed a saving in power of 150 watts per lamp, when 400-watt alternating-current lamps supplied from constant-current transformers replaced nominal 1,200 candle-power open arc lamps. This, assuming the value of power at the switchboard as one cent per kilowatt-hour, would mean an annual saving in the cost of power of six dollars per lamp per year in favor of the constant-current transformer system. The saving of space in the central station has been very considerable, the space occupied being not more than one-tenth as great as the space formerly occupied by the line shaft and arc light dynamos. The repairs on shafting and belting are entirely eliminated, and the maintenance and repairs on the constant-current transformers very materially less than the repairs and maintenance of the arc dynamos and motor, and the services of an attendant have been dispensed with.

Second—Comparison with system using direct-curent arc dynamos, driven by induction motor.

The combined efficiency of the induction motors and series arc generators is approximately 80 per cent. The power factor of the induction motor is 90 per cent. The efficiency of the transformer is 96 per cent, and the power factor of the entire system, 78 per cent. The number of watts supplied to the lamps is approximately the same. By the use of the alternating system there is consequently a saving in actual power and load on the engine of 18 per cent, and in apparent load, and consequently in the capacity of the generators of about 10 per cent.

In the case of a central station operating 1,000 lights in half a dozen neighboring towns, careful estimates were recently made of the relative cost of the wiring system if the lamps were operated from motor-driven arc dynamos placed in the central station, and if operated from constant-current transformers placed in the transformer houses in various towns. There was found to be a saving in the first cost of the installation of the wiring system of $11,000 in favor of the constant-current transformer system. Constant-current transformers take up only about half the space of the motor-driven dynamos; the initial cost of the transformer is much less than the cost of the motor-driven dynamo, and the repairs and maintenance are also less.

Third—Comparison with series alternating arc lamps, operated in series with a reactive coil.

If the reactive coil and arc circuits are placed directly across the bus-bars, they introduce the grounds on the series arc circuits on the general system and also limit the series arc circuits to a comparatively small number of lights. This will, in general, make it advisable where this system is used to introduce step-up static transformers between the bus-bars and the series arc lighting circuits. These transformers serve the double purpose of removing the arc light grounds from the bus-bars, and also make it possible to increase the number of arc lights operated on each circuit. Other things being equal, it is, of course, preferable to have the transformer and reactive coil combined in one piece of apparatus, as it is in the constant-current transformer.

Fourth—Comparison with system using series enclosed direct-current arc lamps, supplied with current from rectifiers.

In this country, up to the present time, it has been impossible to manufacture satisfactory rectifiers intended to operate on a frequency of 60 cycles. It is considered practicable, however, to make rectifiers that will operate at 25 cycles. Even if 60-cycle rectifiers could be made to operate satisfactorily, it is doubtful if they could compete with the constant-current transformer, as in addition to the constant-current transformer, they would have complicated rectifying devices, and would require the services of an attendant.

With 25 cycles it is impossible to operate alternating-current arc lamps. The constant-current transformer system could consequently be used only in connection with frequency changers. Consequently, when central stations operate at low frequency, the introduction of rectifiers will be advantageous, the advantages of the rectifier over the system in which series arc dynamos are direct-driven by motors being in many respects the same as the advantages of the constant-current transformer over the same system.

I venture the prediction that in the near future in the great majority of the cases where alternating current is generated, if the frequency is 60 cycles to the second, the series arc lighting will be by series enclosed alternating arc lamps, and if the frequency is 25 cycles the series arc lighting will be by direct-current enclosed arc lamps, supplied by current from rectifiers.

It is to be hoped that this paper will serve to open up a discussion in which the merits and faults of the various systems of series arc lighting will be fully brought out by those who have had actual experience with the different systems.

NOTES ON LIGHT.

BY WILLIAM ROLLINS.

NOTE XCVI—NITROGEN IN AN X-LIGHT TUBE.

In Note i a tube was figured which regenerated by hydrogen. In subsequent notes simple regulators, both chemical and intermolecular, were described, by means of which this gas could be introduced, when the resistance had become too high. Further experience with hydrogen showed that such vacuums might be unstable, therefore, on tubes with only one regulator not suited for commercial use. Under some circumstances the resistance might be equal to 20 centimetres of dry air and the next moment might have fallen to less than one centimetre; after which it might as suddenly rise again. A more stable vacuum was the one mentioned in Note xxiii, with which dry oxygen was introduced. As this regulator is in commercial use, it may be considered practical, though after a time I have found that the tube gets dull, nor can its original brilliancy be restored by further additions of oxygen. This matter of dullness was referred to in Note lii, and has proved an interesting one to work on. In Note lxxvi some attempts to produce what was called "a ground work" vacuum were mentioned; further experiments were made, some of which indicated that nitrogen had useful properties for this purpose. The appearances in the earlier experiments with this gas may have been due to other causes. In using nitrogen we may employ the sim-

ple means now generally used with my oxygen regulator, but instead of filling the bulb with chemicals to produce oxygen, others to yield nitrogen may be employed; the necessary heat to liberate the gas being obtained from the current used to excite the tube, by placing the regulator bulb in a shunt circuit, with a spark gap in series with it; the length of the gap determining the resistance of the X-light tube, for when this gets too high a spark jumps through the regulator bulb, liberating nitrogen. Before writing this note I tested such a tube on a six-inch Ritchie coil, run on the 220-volt street circuit, using 1,100 watts of energy in the primary and even with a condenser having a capacity of 100 microfarads the light was steady for six hours, the tube yielding the proper quality and amount of light for examining the heart and lungs when placed at a distance of three feet from the screen. It would, therefore, appear as if the regulator was of some value.

NOTE XCVII—ON THE RELATION OF OCCLUSION TO RESISTANCE IN AN X-LIGHT TUBE.

I dislike the word occlusion, because its meaning is, like that of polarization, so indefinite. It is used here to express the attraction existing between particles of solids and gases. On the degree of this attraction depends the resistance of a vacuum tube. To be specific: take an X-light tube with two terminals of metal. Each of these terminals is a mixture throughout its mass of metal and gas—particles held together by attraction. When we exhaust such a tube with a pump, we can get, in a short time, a vacuum equal to a millionth of an atmosphere, but the moment an electric current is sent through the terminals, then the pressure is increased; because the current has torn particles of gas from these particles of metal forming the surfaces of the terminals, sending them into the circulation. Further advances in diminishing the pressure are now slow if the current is continued, but after some hours of pumping and sending a moderate current from a 12-inch Ritchie coil using 50 watts of energy in the primary, the vacuum has become higher, until at length the current will no longer pass, unless the energy is increased. If now the tube, having a nitrogen vacuum, is sealed from the pump and allowed to rest for a time it will be found in sending a current through it that the resistance is less. Leaving out other causes mentioned in earlier notes what is the reason of this? Gas has come to the surface from the interior, so that when the current of electricity is started it finds particles on which to ride the field between the terminals.

We say that electricity always exists on the surface of things, never penetrating the interior. That is well enough as calling attention to one character of electricity, but is not a true generalization. It would be better to say that disassociated electricity resides on surfaces, but as electricity is what holds things together it must exist within the mass. However, as in a vacuum tube, we deal with this disassociated electricity, it may be said to reside on the surfaces of the terminals, and therefore the reason why the resistance of a tube may rise, when the vacuum is falling, is that the current tears off particles from the surfaces of the terminals faster than they come up from the interior. This is why, in a seasoned tube, a powerful current raises the resistance more rapidly than a feeble one. What causes the particles to come up from the interior? This—every particle or group of particles of the metal (in case the terminals are of metal) has associated with it an unknown number of particles of gas. As the electric stress has torn off particles of gas from the metal particles forming the surface, the tendency is for the particles of metal in the interior to give up a part of the gas they hold until the attraction is alike throughout the mass. When this has taken place none of the groups is satisfied, for each has now less gas attached. As a result, the particles are held with greater force, and to use one of Rowland's expressions, we must "cover them with bigger patches of electricity here and there" before we can rupture the bonds of the surface groups, and in consequence we find the resistance of such a tube higher, until finally we get it into a condition mentioned in former notes, where a very high potential is required to start the Varley cathode stream. Then we get that kind of light where the waves are so short they go as well through the dense bones as through the soft tissues. The tube is then useless for medical diagnosis and to produce the proper kind of light again in such old and seasoned tubes we must place obstructions in the path of the flying cathode particles on their way to the target so they may not strike so hard. This we do by lowering the vacuum. But such a tube may not be as good as a fresh one, for it may take more energy to make a like quantity of light.

The San Diego, Cal., Electric Railway Company has just completed the placing of storage batteries in its plant at a cost of $20,000. Various other improvements are in progress at the power house.

VIEWS, NEWS AND INTERVIEWS

Signor Guglielmo Marconi sailed from Southampton for New York last Saturday. It is understood that he is coming to the United States for the purpose of carrying out experiments in wireless telegraphy on a very much larger scale than has ever been done before. As to what the mysterious plans are, neither he nor any of the officials of the Wireless Telegraph Company, of London, cares to say anything at present, as they consider the time is not yet ripe for divulging them.

During a recent storm lightning hit the main light at Sandy Hook, N. J., laid out the electric system at the two lighthouses, and did considerable damage to the watchroom and smashed most of the windows in the tower, after which it entered the oil room, set fire to several cans of oil and cracked the wall of the house. It then followed the electric cable down to the South Hook beacon and laid out the system there. S. P. Jewell, who has been employed for over 30 years at the lighthouse, and his assistant, J. N. Thomas, were near the oil house when the lightning struck. Through their efforts the oil house and adjoining buildings were saved from destruction. Telephone wires on the Hook were disarranged and some telephones burned out, but no other damage was reported. The electric current is furnished by the power station which also operates the electric buoy lamps in Gedney's Channel.

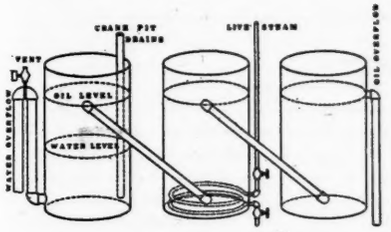
A large Chicago grain and stock brokerage firm has leased a private telegraph wire from Chicago to San Francisco, according to the New York *Sun*. The firm already has a private wire from New York to Chicago, so that it now controls for its own exclusive use a wire service of 3,000 miles from ocean to ocean. Some idea of the profits that such firms must obtain by means of their private wire services may be gained by the fact that the 1,000-mile section of wire from this city to Chicago costs $18,000 annually, which would indicate a total for the entire 3,000 miles of about $54,000. Another form of Wall street wire service that yields large revenue to the ocean cable companies is that which is associated with the arbitrage trading, based upon simultaneous varying quotations for the same stocks in New York and in London. The average time for the round trip or for an arbitrage order to London and the answer telling of its execution in the market there is between four and one-half and five minutes.

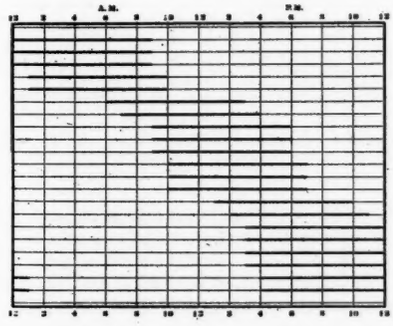
OPERATING ECONOMIES IN CENTRAL-STATION PRACTICE.*

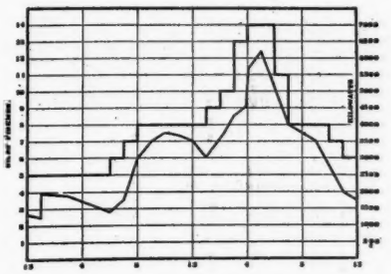
BY W. L. ABBOTT.

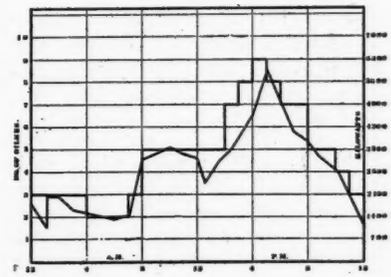
In every central station there grows up a characteristic system of practices, good, bad or indifferent, due partially to peculiar environments and partially to the ability of the operating force. Through natural selection the best of these practices are gradually crystallized and become the unwritten code of rules for the direction of the internal affairs of the station.

Some of these practices, while the very best for the station in which they originate, may prove very unsatisfactory when transplanted into other stations, yet it is largely due to the cordiality with which central-station managers impart to each other, and adopt on trial from, new methods, that the present rapid improvements in operating details are being made.









FIGS. 1, 2, 3 AND 5.—DIAGRAMS ILLUSTRATING MR. ABBOTT'S PAPER ON "OPERATING ECONOMIES IN CENTRAL-STATION PRACTICE."

It is in the hope that some of the methods hereinafter outlined may be new and feasible in other places that these suggestions are offered.

The saving and renovating of waste and oil is an ever present and variously handled question in all stations. Some simply use the waste until it is oil-soaked and then burn it under the boilers; others go to the other extreme and use wiping towels, which are carefully saved, washed and used over again. We favor a middle course, using a good quality of waste, first on the finer parts of the machinery, and then for coarser work, after which it is put through a washer consisting of a train of rolls, over which hot water is running. This extracts nearly all of the oil and much of the dirt. The oil and water are caught in a receptacle, the oil separated and passed to the oil purifier, and the waste is put into the drier. This drier consists of a sheet-iron box 30 inches square and six feet high, filled with shelves, one above another, made of wire netting and spaced about 10 inches apart, for the reception of waste to be dried. The case stands a few inches from the floor, and in the bottom, which is open, is a steam coil. A door occupies one full side, and to the top is connected an eight-inch galvanized iron pipe leading to the boiler breeching, for the purpose of inducing a draft. The whole thing is quite simple and inexpensive, yet it will thoroughly dry a charge of 200 pounds of damp waste in a few hours. This dry waste is somewhat harsh and knotty, but has better absorbing qualities than new waste, and we use and wash it over and over again.

In practice the oilers are allowed but three-quarters of a pound of new waste on a shift, to keep a 1,200 horse-power engine clean, but they are allowed all of the washed waste they want.

In separating oil from waste it is difficult to say which is the by-product and which the direct product, as from 100 pounds of oily waste we get 40 pounds each of oil and waste, and one product is about as valuable as the other.

The amount of engine oil used at our Harrison street station has been reduced to the lowest possible minimum, I think, as it amounts to only about 50 gallons of new oil each month. This is obtained by catching and re-refining all the lubricating oil used on our machinery, which is quite readily possible on vertical engines. The drains from our crank-pits are carried down into the oil refiners, and the oil from the waste is all saved and put through a process which makes it better than new oil. This may sound like an exaggerated statement, but I will explain later on why it is better than new oil. I have spoken of oil refiners and of refining the oil, instead of filters and filtering the oil, for the reason that we have no filters and do no filtering, but purify the oil by settling and boiling. Our filters consist, essentially, of three tanks, as shown in Fig. 1, the first of which receives the oil from the engines mixed with cylinder drips and water from journals, etc. When this enters the first tank, which is, say half-full of water and half-full of oil, the water and oil separate; the water goes to the bottom where it is drawn off through a trap; the oil goes to the top and is drawn off through an overflow. From the first tank the oil flows to a second tank, in which is a steam coil, under a pressure of, approximately, 100 pounds. This is for the purpose of heating the oil up to about 250 degrees, at which temperature the water is driven off in the form of steam. Owing to the surface tension of the oil around the small globules of water which is held in suspension with it, the water will not vaporize at a lower temperature. This tank is of such a capacity that the oil is about two days in passing through it. From the second tank, the oil goes into the third tank, where it is allowed to stand about the same length of time, and where any sediment it may contain will be deposited. From the third tank the oil overflows into a large storage tank, where it is kept until it is drawn off to be used. Few of those who have not looked into the matter would realize how much water will be absorbed and held in suspension by oil which contains a small trace of animal matter, and how difficult it is to break up the combination, once it is formed. Those of you who operate oil filters may have sometimes wondered at the accumulation of grease in them; this grease being a soft, jelly-like substance of the consistency of warm lard, or perhaps even thicker. This grease is no more than a combination of mineral oil, a small trace of animal oil, and about 40 per cent water, and if it were placed in a vessel and heated up to about 250 degrees, the water would be driven off, perhaps with explosive force if heated too rapidly, but if the work is carefully done the water can be separated, and what is left would be the best kind of lubricating oil, containing a small trace of animal oil, and in our case all the cylinder oil from which the animal oil is derived; and it is this mixture of the cylinder oil with the engine oil which gives it its heavier body and better lubricating qualities. The oil which is expressed or washed out from the waste apparently contains more cylinder oil than that which comes from the engine drains, and on this account those who throw away their waste not only lose the waste, but the richest part of the oil, which is contained in it. That this amount is considerable will be seen from the fact that from every 100 pounds of oily waste we get about 40 pounds of clean waste and 40 pounds of oil.

The question of cylinder lubrication was once a very perplexing one for us, but after studying and experimenting, we settled the question in such a way that it has not been open for several years. We had great trouble with cylinder oil, and had difficulty in finding an oil which

*Read before the National Electric Light Association at the meeting in Chicago, May 22, 1900.

would lubricate all of the cylinders of our triple-expansion engines from one lubricator. We have not found such an oil and do not expect to. We could find an oil which would lubricate the high-pressure cylinder, and we could find an oil that would lubricate the low-pressure, but we could not find a combination which would lubricate all of the cylinders perfectly. We have, therefore, adopted an oil which will lubricate the high-pressure cylinder excellently, the intermediate moderately well, while the low-pressure shows only a slight trace of oil; but as there is no cutting or scratching in the low-pressure while it runs dry, and as the high-pressure cylinder makes a vigorous protest if allowed to run dry for a few moments only, we have adopted the oil which will give the best results in the high and let the low be content with what it gets.

The results of our experiments have convinced us that the only oil to use in a non-jacketed cylinder, where it would come in contact with very wet steam, is one which is very highly compounded. It must also be an oil of a high fire-test, and the reason why it does not lubricate the low-pressure cylinder as well as the high, in our opinion, is that the temperature of the steam in the low-pressure cylinder is so low that the oil will not remain atomized in the steam, but washes down and combines with the water of condensation which has formed in the other two cylinders, and passes through the low in an emulsion with the water. To prove this theory I have tried the plan of mixing a cylinder oil of a high grade and high flash test with a light oil of a low flash test, and feeding it through one lubricator through all three of the cylinders. The result shows a fair trace of oil on the walls of the low-pressure cylinder, and we ran our engine with this kind of cylinder lubrication for several months, but finally decided that the best results for the entire engine were obtained with that oil which gave the best lubrication in the first cylinder. We now use a heavily compounded high fire-test oil, fed into the steam pipe near the throttle. We find that a gallon of oil so fed will give good lubrication for a 1,200 horse-power engine for 12 hours. I have seen a compound engine of this capacity fed at the rate of nearly a gallon an hour without obtaining satisfactory lubrication, the whole trouble lying in the fact that the oil was not adapted to the particular conditions under which the engine was working, and I think this may account for the unmeasured praise or unstinted abuse which different brands of good oil receive from different engineers, and I think, furthermore, that the difference between a good oil and a poor oil made from high fire-test stock lies almost wholly in the amount and kind of compounding.

In arranging an operating force and the pay roll of the central station the superintendent should aim, as in all other matters, to get the maximum of results, with the least expenditure of money. To do this he should carefully arrange his force so that he would at all times have men enough to take care of the amount of work to be done. Also, his scale of wages should be carefully graded so that the operatives doing the same class of work should receive the same pay, and that the rate of pay to the different classes of workmen should be in proportion to the skill, responsibility or manual labor required. Further than this, a considerable saving in money can be made by paying the operatives partially in hopes and promises. By this I mean to have a well-defined and well-known line of promotion and each one knows his position in that line, and that his chances for promotion depend upon his ability, fidelity and length of time in the service. Any really good, ambitious young man is ready to begin work at the bottom of the ladder, and will work along contentedly on small wages if he is assured that the promotions to come will be awarded upon the above terms and not by favoritism. The most demoralizing and disorganizing practice that can be introduced into a central station is to put a new man, the relative of some official, or the friend of some politician, into a desirable position over the heads of equally good men who have borne the drudgery of hard work of inferior positions, hoping and expecting that when there was a vacancy in a better position they would have the preference.

In many stations the force is divided into a night gang and a day gang, the day gang going off as the night gang comes on, and vice versa. I do not know that this practice is as general now as it was formerly, but I never thought it was well adapted in central-station work. In the first place the hours are too long, and in the next place, it does not give the best distribution of labor. The number of men in the station does not vary according to the load. The practice which we instituted several years ago, of bringing the men on one or more at a time, an hour or so apart, and letting them off in the same way, we find can be made to exactly meet the requirements of an uneven load, and enables us to rotate the different men of the same class through all the different shifts during the course of one or two months, thus making the work and the hours of all exactly alike in the cycle. At the end of each week the schedule is made up for the week to come, for each of the different classes of operatives interested, and this is posted on Saturday night, so that as the men go off work on the following Sunday it is known what shift each will have during the coming week. These schedules are altered from week to week, increased or diminshed as regards the number of men, and changed in form to conform with the varying conditions of the load curve.

To illustrate by a set of December schedules: The problem to be solved is to arrange the schedule so that there will be at any time enough men for the work, without having too many men around at other times, and, furthermore, to arrange the shifts so that none will be obliged to go home between the hours of one and six in the morning.

As we are not sure what the load will be from day to day, or a week ahead, we are obliged to provide men enough to take care of what we assume will be the reasonable maximum. It is, of course, impossible to meet the requirements exactly without breaking a man in two and using the pieces in nonconsecutive times of the day, but with a little care and study, it is possible to arrange the schedule to very nearly meet the exact requirements. Take, for example, the firemen's schedule for the week commencing December 18, 1899, as shown in Fig. 2. We start at midnight with five firemen; two of these are relieved at one o'clock by two other men who come on at that time. As the load from midnight until six o'clock is quite irregular, owing to the variable amount of charge required by the battery from day to day, we have rather more firemen on during this period for the amount of work done than we have during other times of the day. At six o'clock in the

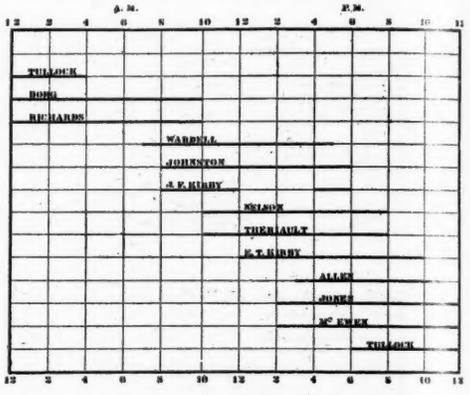


FIG. 4.—"OPERATING ECONOMIES IN CENTRAL-STATION PRACTICE"

morning the load begins to pick up, and has nearly reached its morning maximum by nine o'clock. To take care of this, our force of firemen is increased by one man each at six, seven and eight o'clock, there being by that time eight men on, and the force is held at that number until one o'clock in the afternoon. During this time several men come on and others leave, but the number at work remains the same. The slight drop of the load at noon is not followed by a corresponding change in the number of men, but it is taken advantage of as a slight breathing spell, and gives the men an opportunity to clean fires and eat their dinners. After the midday drop in the load there follows a gradual rise until four o'clock, which we anticipate by bringing a man on at one and another on at two; at four o'clock the load rises abruptly to the maximum shortly before five. We provide for this by bringing three men out at three o'clock to get their fires in good shape ready for this hard pull, and, finally, at four o'clock, the last man comes, which brings the total number of firemen on at this time of the day up to 14 men. After five o'clock the load gradually declines, until midnight, when it is only about one-fourth as high as it was at five. Owing to the way in which the men have been brought out their shifts are finished so that the force is automatically decreased in proportion as the load de-

creases. and we have during the day worked 21 firemen, who have altogether burned about 210 tons of coal, and have been so distributed that we have at all times had an excess of one or more men for the work, and none have been overworked. Fig. 3 shows the load curve for December 21 and also what we may term the firemen curve for the same day, which shows at a glance how nearly the size of the firing crew was adapted to the requirements. Fig. 4 shows the oilers' schedule for the same week, and Fig. 5 shows how nearly the number of oilers were proportioned to the amount of work to be done on December 21.

The greatest possibilities for saving or wasting about a steam plant are undoubtedly in the coal pile, but as it is a dirty proposition and many of its features not well understood, the subject does not receive the consideration to which it is entitled.

The average ambitious engineer will spend much time and care on his engine to be sure that the indicator cards are perfectly symmetrical, that the points of cutoff are equal, that the release is in time and that the compression rises to meet the admission in a smooth, rounded curve. This is proper and commendable, yet the same time spent in studying the conditions of combustion in his furnace might show him a way to make a saving in fuel fourfold greater than is possible in the final refinements of the indicator cards.

A fireman whose wages amount to, say, 20 cents an hour will burn during that time fuel costing 10 or 15 times as much as his wages. It would not be possible by any sort of driving to save half of the wages, but it is readily possible, by properly watching and instructing the fireman, to save double his wages in coal. In the first place, great care should be exercised in the selection of the coal to be used. I believe that the cheapest coal is that which has the greatest amount of combustible for the least amount of money, provided the furnaces are of the proper kind and ample in capacity to make the required amount of steam from them. The very cheapest kind of Illinois screenings, costing less than $1.50 a ton, will not have less than 10,000 British thermal units a pound, and the very best of eastern lump, costing $4 a ton, will not have more than 14,000 British thermal units a pound. This means, then, that for equivalent heating qualities the cheapest screenings cost about half as much as the high-grade coal.

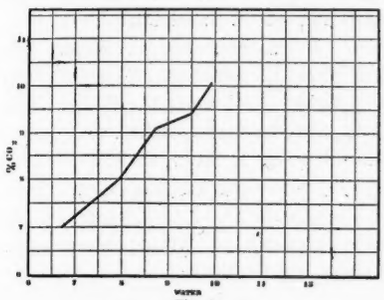


Fig. 6.

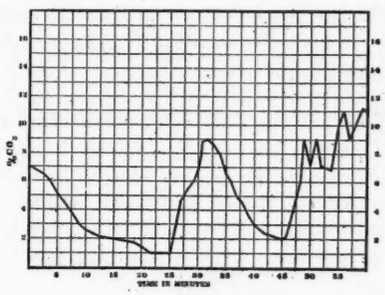


Fig. 9.

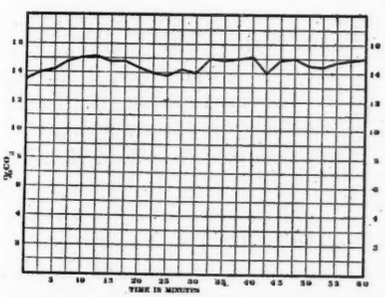


Fig. 7.

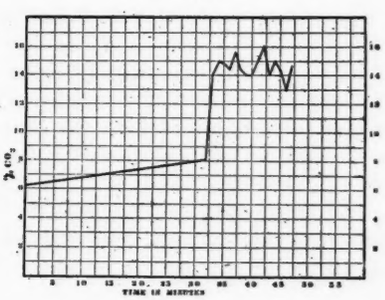


Fig. 10.

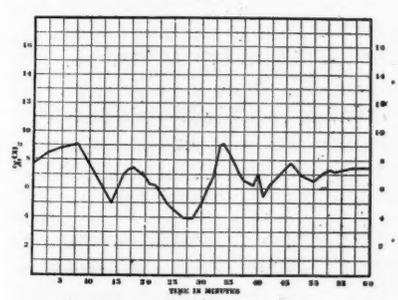


Fig. 8.

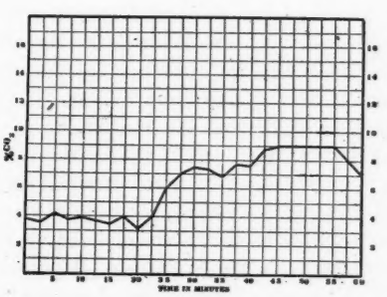


Fig. 11.

DIAGRAMS ILLUSTRATING "OPERATING ECONOMIES IN CENTRAL STATION PRACTICE."

Having selected the coal, the next problem is how to burn it properly. It is commonly understood that 12 pounds of air are needed to properly burn one pound of coal. It is also commonly supposed that in practice about twice this amount of air passes through the fire, but just how much actually passes and under what conditions are the best results obtained are impossible to determine without making analyses of the flue gases. Fortunately, this has now become a very simple operation and one which can be performed and understood by anyone competent to take charge of a large boiler room. These tests often show the most surprising and disappointing results. The analyses are made to determine the percentage of carbon dioxide in the flue gases. Under perfect conditions it can run as high as 20 per cent, but it is not unusual to find samples running as low as two per cent of dioxide. This brings down the economy, for two reasons: First, the gas in the firebox is diluted with an excess of cold air and cooled down, and, secondly, the amount of gas, being increased in volume, passes through the boiler more rapidly and does not give up so much of its heat. It is almost a paradox that within reasonable limits the more the gases are cooled down in the furnace by the admission of excess of air the hotter they will pass away from the boiler. The two causes of excess of air in the flue gases are, first, running boilers on too light loads, and secondly, careless firing.

In a station where the load is much higher for a few hours than during the rest of the day, the tendency is to have too many boilers in service during the period of light load. The natural result is that the fires are run thin; the grates get bare in places and a great volume of air is drawn in, and only a small portion of it comes in contact with the fuel.

Careless firing is always a flagrant waste of fuel. An engineer may be aware that he is not getting the results which his tests lead him to believe he should have, and yet, in a boiler room where several men are working, it is exceedingly difficult to fasten the blame on any one of them, unless one can examine the chips the men make, or, in other words, the flue gases.

To follow intelligently the work of the individual fireman, we have installed in our boiler room a device called the econometer, through which is induced a small current of gas from a boiler breeching. The weight of this gas, changing with its composition, moves a pointer across a dial, thereby indicating continuously the varying percentage of carbon dioxide in the flue gas. From this device are run individual pipes to the breeching of each boiler, and all is so arranged that samples may be drawn from several boilers and tested in a few minutes, or a continuous test may be made of the performance of any one boiler.

Readings taken from this instrument at regular and short intervals, when plotted, form a curve which is a very comprehensive record of the conditions of combustion during the time of observation. A few of such curves I submit here-

with: Fig. 6 shows the result of a test made to determine the relation between boiler efficiency and percentage of carbon dioxide. The results show that within the limits tested the two are almost directly proportional. Fig. 7 shows the results of skillful and even firing. Fig. 8 shows the results of careless and uneven firing. Fig. 9 shows, first, what occurs when a fire is cleaned in a leisurely manner, the dioxide dropping to one per cent; then followed a charge of coal, which got the furnace in good working condition; but as the fire was not replenished in the next 15 minutes it burned so thin that it is doubtful if the boiler was making steam at all. The latter part of the curve shows the automatic improvement in the fireman as soon as he observed that he was under serveillance. Figs. 10 and 11 show how the work of a fireman may be improved by giving him intelligent instruction.

The above are a few of the methods we have adopted for reducing operating costs.

Some of them may appear trivial, but when we consider that $100 saved is $100 added to the surplus, which is as good as a $500 increase in the gross earnings, and that to add $500 monthly to the gross earnings would require an investment of, say, $25,000—when we consider this we may realize what a valuable asset is an engineer who is prolific in methods for keeping costs down or is ready to adopt such methods from others.

Automobile Club of America.

C. J. Field, chairman of the technical committee of the Automobile Club, has sent out a letter to the members, of which the following is a part:

Acting under the directions of the board of governors, the technical committee is preparing the details for a series of trials and competitive tests, which are intended to develop the strong features in turning, stopping avoidance of obstacles, hill climbing and other various manœuvres, which will develop the strong points of each one of the different types of automobiles, and also comparative ones in competition with horse-drawn vehicles, the idea being to make this an interesting and instructive series of tests for the benefit of the club members and the public at large, and also to develop the question of safe speeds for the different types of automobiles.

Electric Railways in Gothenburg.

United States Consul Bergh reports that the city council of Gothenburg, Sweden, has decided that the city itself shall build and run the new electric street railways. In all probability the proposed lines will be extended considerably, and more rolling stock and other material will be needed than at first estimated. American firms intending to compete with Swedish and German manufacturers should address communications to Figge Blidberg, Esq., engineer and manager of the city tramways, Gothenburg.

ELECTRIC RAILWAYS

The electric street car system of Greenville, Miss., was inaugurated a few days ago. The service is started with six cars on the principal business streets, and will be extended as the growth of the town and business justifies.

The New York State Board of Railroad Commissioners has authorized the Cayadutta Electric Railroad Company, which operates between Fonda, Johnstown and Gloversville, to issue a mortgage for $600,000.

The town council of Converse, Ind., has granted a 50-year franchise to James Linn, Carey E. Cowgill and M. S. Howe, of Wabash, for an interurban electric car line, which is to be built from Rochester to Kokomo, *via* Wabash, Converse and Greentown, 80 miles in all.

The directors of the United Railways and Electric Company, of Baltimore, Md., at their recent monthly meeting, formally announced that the semi-annual interest of two per cent on the income bonds and the dividend on the preferred stock would be paid on June 1. A statement was submitted showing that the interest and dividend had been more than earned during the past six months.

Summer tourists and residents of Chicago who spend their vacations in northern Wisconsin are assured by the promoters of new rail lines that in 1901 they can make the trip from Chicago to the pine wood regions and the resorts north of Green Bay by an all-electric route. Lines are being built or surveyed from Menominee southward, reaching to Green Bay, thence to Manitowoc or Fond du Lac and through Sheboygan to Milwaukee. With the completion of the short gap between Waukegan and Kenosha the line from Chicago to Milwaukee will be finished.

Direct electrical street railway communication between Providence, R. I., and Fall River, Mass., will before long be a fact. The plans of the Providence & Fall River Street Railway Company, which are already well under way, provide for a line to run along the main road between Providence and Fall River, commencing at the tracks of the Somerset & Swansea Street Railway Company at or near the westerly end of the Slade's Ferry Bridge, and extending through the towns of Somerset, Swansea, Rehoboth and Seekonk, to the Rhode Island state line. This calls for the building of tracks 14 miles in length in Massachusetts. The Massachusetts terminus of the road will be at Rulin's River Bridge.

The following are the incorporators of the Phillipston, Mass., Street Railway Company: T. H. Goodspeed and Wilson D. Smith, of Athol; C. Waldo Bates, Walter White, H. C. Hutchins and D. W. Baker, Phillipston; P. Blodgett, Frank E. Johnson and Charles E. Ingalls, of Templeton. A board of directors was chosen consisting of P. Blodgett, T. H. Goodspeed, F. E. Johnson, C. Waldo Bates and Mark E. Johnson. They organized as follows: President, C. Waldo Bates; clerk and treasurer, Chas. E. Ingalls. Capital stock is fixed at $100,000, and subscription books are now open. It will be a continuation of the Templeton road with terminal at Athol; the distance is about eight miles.

The Dunkirk, N. Y., & Point Gratiot Traction Company has been reorganized. The directors elected are: Daniel F. Toomey, Andrew C. Dotterweich, J. C. Haggett, B. L. Harrison, M. P. Toomey, B. E. Farnham, C. J. Carney and Harry C. Hequembourg. The officers elected for the year were: Daniel F. Toomey, president; A. C. Dotterweich, vice-president; H. C. Hequembourg, treasurer; J. C. Haggett, general manager; B. E. Farnham, secretary and cashier. The contract for building the road to Hickoryhurst was given to the International Construction Company, of Detroit. The road is to be finished by June 25. The Dunkirk & Fredonia Electric Street Railroad Company will supply power to the company and furnish the rolling stock to be used.

The Newark & Marion Railway Company is organized under the railroad law, duration 100 years; capital stock, $100,000, all common stock. The shares $100 each. The principal office will be located in Newark, N. Y. The company will operate an electric road between Marion and Newark. The length of the road will be eight miles, wholly within Wayne County. It will start on Buffalo street in Marion, near the Wayne County Canning Company's plant, and end near the Central Hudson depot in Newark. Directors for first year are: Earnest V. Pierson, Frank D. Burgess, William H. Nicholoy, William H. Kelley, all of Newark; Caleb L. B. Hylee, Clinton L. Tylee and William C. Snow, of Penn Yan; Charles H. Scutt, of Marion, and Henry R. Sill, of Bluff Point.

Report of the Committee on the Photometric Value of Arc Lamps to the National Electric Light Association.

This committee, composed of Henry L. Doherty, W. E. Goldsborough and J. Q. Brown, presented a progress report at the Chicago meeting of the National Electric Light Association, on May 22. Through the good offices of Purdue University, La Fayette, Indiana, the committee has been able to take advantage of the excellent laboratory facilities afforded by the School of Electrical Engineering in that institution, of which Professor Goldsborough is the director.

The tests outlined by the committee are of a very extensive character and, should they be carried to a finish, a vast store of useful data will be given to the electrical engineering profession. Arc lamp manufacturers and manufacturers of carbons throughout the country have very earnestly come to the assistance of the committee, and the report contains a detailed acknowledgment of their cooperation.

After a report on the moneys expended in the progress of this work and an acknowledgment of the generosity of the members of the association who have contributed to the arc-light fund, there follows a letter from Professor Goldsborough, in which he outlines the scope of the tests, and transmits the report of Professor C. P. Matthews, photometrist for the committee.

Professor Matthews first acknowledges the valuable assistance rendered by six senior students of the School of Electrical Engineering, at Purdue University, Messrs. G. H. Kelsey, A. B. Golden, L. W. Cromwell, O. F. Slimp, P. B. Sawyer and C. Branigan. He then goes into a detailed description of the methods and devices perfected by him to minimize the errors and uncertainties arising in arc-light photometry. The most unique of these is the adoption of two mirrors instead of one to direct the light from the source to the photometer. These mirrors are placed on opposite sides of the arc, and, as a result, the illumination of the photometer disk is rendered fairly uniform. Thus the fluctuations, so troublesome when measurements are made in the usual way, with a single mirror, are greatly reduced. The color difference is also lessened by the use of a rotating, sectored disk of very small angular aperture. This diminishes the apparent illumination of both sides of the photometric field to a point where the color difference ceases to be troublesome. Another device for lessening the labor of the process and also the retinal fatigue is the recording drum. This has been already described, but in these tests it has been used with an electromagnetic recorder, which somewhat enhances its usefulness. To test the efficacy of this combination of devices in eliminating errors peculiar both to the source and to the method, readings were made by a number of observers. These measurements show a very satisfactory agreement, demonstrate that the end sought has been accomplished and that personal and other errors are not greatly in excess of those met with in the photometry of steady and monochromatic sources.

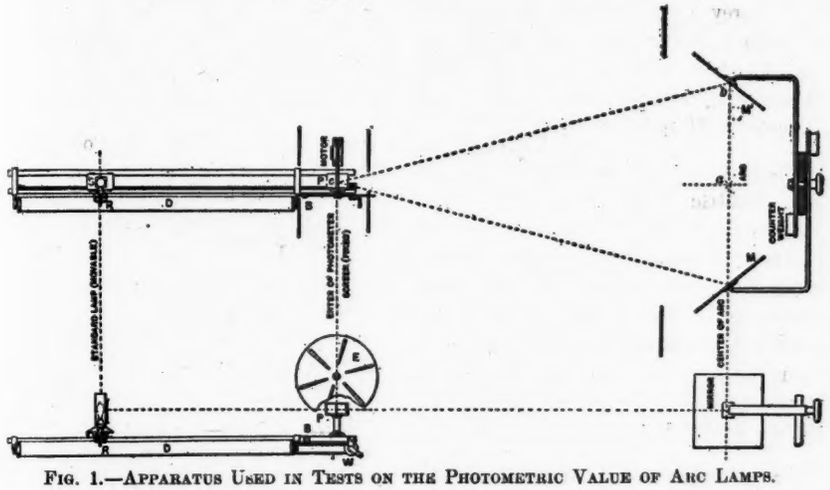


FIG. 1.—APPARATUS USED IN TESTS ON THE PHOTOMETRIC VALUE OF ARC LAMPS.

Reference to Fig. 1 will show the disposition of the apparatus as used in these tests.

The two mirrors, M M' are mounted at the extremities of iron arms and are suitably counterbalanced, as shown. The arc is fixed in the centre of rotation at *a*, and light is incident upon the photometer disk at *c*, by the two paths shown in dotted lines; direct light from the arc being cut out by a screen not shown in the figure. This plan necessitates a fixed photometer P, and, in order that a variable illumination may be produced to balance that due to the arc, a cord and windlass are arranged, W permitting the observer to move with facility the secondary standard S, which is a glow lamp.

At D is shown a long wooden cylinder upon which is wrapped the paper to receive the records of the test. These records are made by an electro-magnetic device R, which punctures the paper whenever an electric circuit is closed at the button B.

The observer, seated before the photometer in a closely screened enclosure, operating with one hand the windlass, and with the other the push-button, is enabled to take settings with relatively great rapidity and accuracy. At a point 200 centimetres to the right of the photometer disk a reserve standard is mounted on an arm which may be swung into a position in line with the bar. This reserve standard was carefully evaluated once for all in terms of the Hefner lamp. To determine the intensity of the secondary standard S, it is only necessary to turn the reserve into position, and record a series of readings in the same way as for the arc. This operation is carried out at the end of each test, or more frequently if any change has been made in the temporary standard. Thus, it will be seen that, should the lamp under test be found particularly weak at certain angles, the limit of the bar might be reached in the attempt to get a setting. In such case, it is necessary to stop down the temporary standard, and to again refer it to the reserve. It may be added that the reserve is never allowed to burn more than a few minutes, and can not possibly deteriorate under such conditions of use.

With this disposition of the mirrors, the angle of incidence at the photometer disk is constant. In Fig. 1 this angle is shown at more than twice its actual value in order to reduce the length of the drawing. The real value of this angle was 5 degrees 54 minutes. To make a correction for this lack of normal incidence would mean the division of the intensities, as found, by the cosine of 5 degrees 54 minutes, or .9947. Failure to do this introduces an error of about one-half of one per cent, which is clearly negligible in work of this character.

It is, of course, necessary in testing sources with large globes or shades to use mirrors of size such that the globe or shade may be seen in its entirety when the eye is placed at the point C (Fig. 1); and it is further necessary that the distance *abc* should be large.

It is important to note that the double-mirror method, while enormously diminishing the fluctuation due to wandering of the arc, can have no effect on such fluctuations as are due to variations in length of the arc, or to variations in the current.

A preliminary test of much interest is described by the writer as follows: "When an opalescent inner globe is used, the globe itself becomes more or less luminous by diffusion. The diffusion differs with the height of the arc in the globe, that is to say, with the length of the lower carbon. To ascertain the magnitude of this effect, I have carried through three tests on the same lamp and inner globe, and also the same carbons, the lower carbons being cut successively to the lengths of 4¾, 2¾ and 1¼ inches. The results appear in Fig. 2. In every case the arc was placed at the centre of the mirror system.

An inspection of these results shows that least light is obtained with the arc at the top of the globe, and most light

when the arc is at the mid-point. This is explained in part by the fact that, with the arc at the top, a good part of the luminous flux is incident upon the non-reflecting surface of the gas-cap.

While the second and third positions yield a considerably increased flux of light with a clean globe, they must be considered as impossible conditions in practice, since, by the time the arc has descended to these points, the globe has received a coating. The net result, then, as the lamp burns, is due to an increase in light flux due to the descending arc, and a diminution in light flux due to the formation of a coating. How this affects the quantity of light emitted, *i.e.*, the product of flux and time integrated throughout the life of the carbons is a subject for future investigation, and involves the questions of carbons, shape of globe, etc.

In the tests which follow, I have chosen the initial condition as the simplest to obtain, even though the light emitted may be less than at some subsequent period in the life of the carbons.

Should anyone desire to test a lamp for the purpose of obtaining comparative results, he would not be under the necessity of burning the lamp for many hours to get the proper conditions, as he would necessarily have to do were one of the lower positions chose in these tests.

The first investigation taken up by Professor Matthews is intended to settle the status of the 110-volt direct-current, enclosed arc lamp, as found in its commercial form to-day. Reports are made upon eight different lamps of this type. The tests were made upon the lamps as sent by the makers, but with a certain uniformity in conditions.

These conditions are:

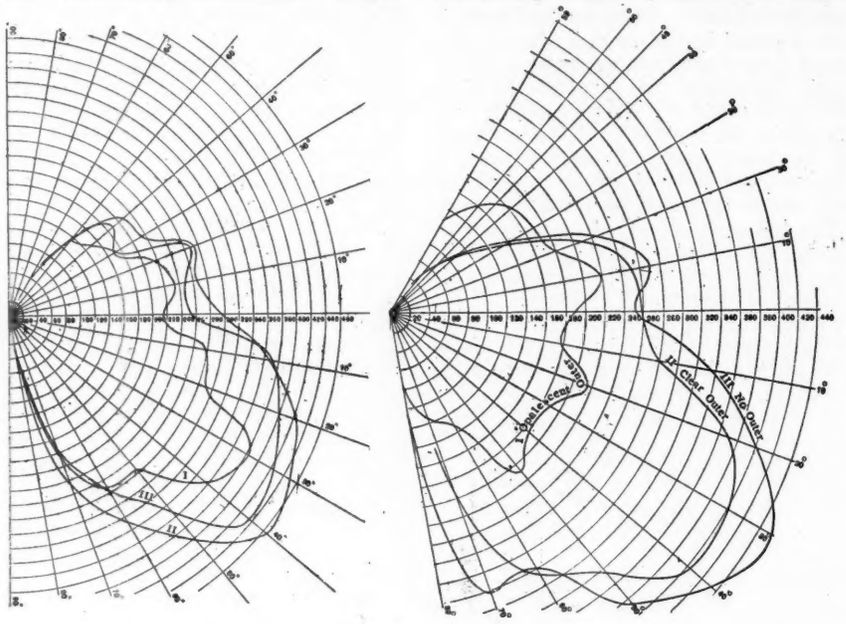
1. The same brand of carbons throughout.

2. An opalescent or milky inner, and a clear outer globe, as supplied.

3. An opalescent inner and an opal ground, or milky outer globe, as supplied.

Fig. 3 shows the results of a representative test on one of these lamps. The regularity and relative position of these curves are indicative of the accuracy of the methods employed.

The curves show very clearly the slight absorption of the clear outer and the large absorption of the opalescent outer. The clear outer globe shows some diffusion, as it tends to round out the curve. Thus there are two regions where curve II extends beyond curve I. In the case of the opalescent outer globe, the diffusion is so marked that the luminous intensity is practically constant throughout a very large solid angle. In the higher angles above the horizontal, the intensity is greatly increased, producing the effect, approximately, of a luminous sphere of equal intrinsic brightness. This results in the elimination of shadows, and the production of a pleasing light for interiors. The quality of light is also changed to a considerable extent, through the absorption of the excess of violet rays otherwise very marked in the light of the arc. This result is attained, however, at a diminished efficiency. In this and nearly all the curves with the opalescent outer globes, a certain wavy outline is noticed. This effect is due, in large part, to the variations in the diffusive power of the globe itself. One finds difference in thickness and translucency to a considerable extent in such globes, and, as the angle of view changes, these differences would tend to distort the distribution curve.



FIGS. 2 AND 3.—CURVES OF ARC LAMP TESTS.

At a common terminal electro-motive force of 110 volts, seven of these lamps take an average current of 4.90 amperes, which means an average total power consumption in each lamp of 539 watts. With 80 volts at the arc, this power is divided into 147 watts waste in the resistance coils and 392 watts in the arc. The average yield of light, expressed as mean spherical intensity, is:

Opalescent inner, no outer[a], equals 256 H. U.

Opalescent inner, clear outer, equals 207 H. U.

Opalescent inner, opalescent outer, equals 177 H. U.

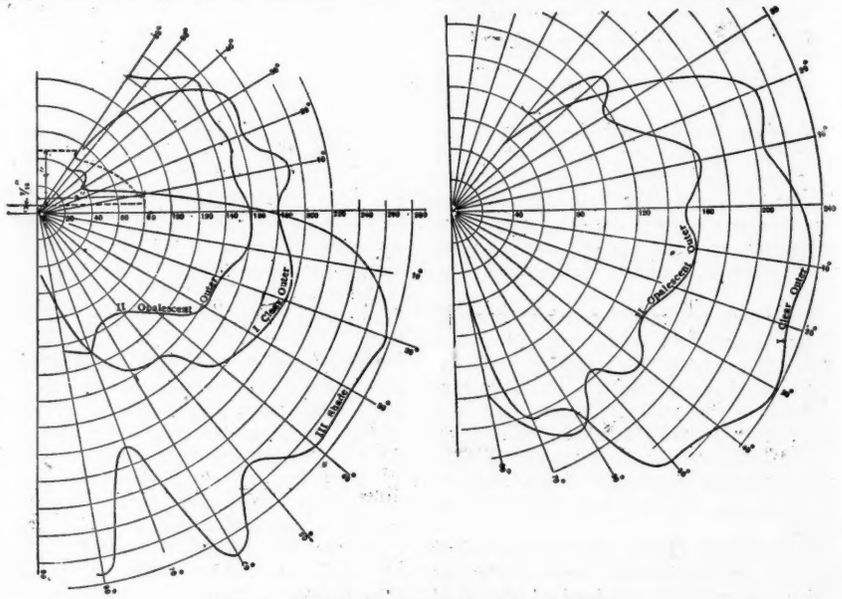
Hence the power required to produce one unit of light in this type of lamp is:

Opalescent inner, no outer*, equals 2.10 watts.

Opalescent inner, clear outer, equals 2.66 watts.

Opalescent inner, opalescent outer, equals 3.04 watts.

In conclusion, attention may be called to the fact that these figures give the value of this type of lamp as a light *producer*, and not as a light *distributor*. The efficiency of the type as a distributor of light can best be found from a consideration of the curves of illumination—a matter



FIGS. 4 AND 5.—CURVES OF ARC LAMP TESTS.

*The computations for no outer globe have not the same value as the others, for the reason that the number of such tests was less.

which does not form a part of this investigation.

The second investigation reported deals with the general status of the 110-volt, alternating-current enclosed arc lamp in its commercial form. Conditions similar to those described in the preceding tests obtained throughout this investigation. Seven lamps were subjected to test. Of the results, none are more instructive than those obtained on lamp 106 (Fig. 4).

The highly beneficial effect of a shade on an alternating-current lamp is here well shown. The large upward lobe of the distribution curve is intercepted and turned into useful directions. It is to be remembered that these distribution curves represent the state of affairs when the lamp is newly trimmed. As the arc burns lower, the upward flux of light is strengthened and the value of the lamp as a light source improves, because the shade then reflects a larger flux of light into useful directions. The shade in this case extends downward to a plane about one-half inch above the arc, when the latter is at its highest point. The horizontal intensity with shade is slightly less than with clear outer globe, showing that the latter strengthens this intensity by diffusion more than it reduces by absorption. The increase in intensity from the horizontal to 20 degrees B is very marked when the shade is employed in the position here indicated, and these are angles of most importance in street lighting, if not in interiors. The mean hemispherical intensity is altered by the substitution of the shade for the clear outer globe in the ratio of 254.169, or 50 per cent increase.

It is worth noting that the curvature of this shade is admirable for the effect sought. A shade which is concave outwards will divert a portion of the luminous flux upwards, where it is largely dissipated by absorption.

As to the efficiency of this type of lamp, we have in the following table a recapitulation of the power measurements on the alternating-current lamps. The mean power consumption of seven lamps is 417 watts. The average value of the mean spherical intensity is:

With clear outer globe, 159 H. U.

With opalescent outer globe, 130 H. U.

Therefore, as light producers the average efficiency is:

With clear outer globe, 2.62,

With opalescent outer globe, 3.20

in watts per mean spherical Hefner unit. The mean power in the arc is 342 watts, and in the mechanism 74 watts.

ON THE RELATIVE MERITS OF THE DIRECT-CURRENT AND ALTERNATING-CURRENT LAMPS AS LIGHT SOURCES.

Regarding these lamps merely as light producers, the average direct-current lamp yields, with opalescent inner and a clear outer globe, 207 H. U., whereas the average alternating-current lamp for circuits of the same pressure yields 159 H. U., which gives the former lamp an advantage as a light source, irrespective of efficiency, in the ration of 48.159 or 30 per cent. It is pretty well demonstrated that the alternating arc is *per se* less efficient than the direct-current arc. Just what the proper ration may be is a matter for physical research, and varies with several factors, such as current density, wave form, etc. We have no data in these investigations to furnish reliable information on this point, as there are too many variable conditions met in the lamps as found in their commercial form.

Comparing the average performance of the lamps in the first series of tests with the average performance of the lamps in the second series of tests, one finds very nearly the same power consumption per light unit, *viz.*:

TABLE XX.

No.	Current.	Watts Consumed.					Mean Intensity in H. U.			Mean Watts Per		
							Spherical.		Lower Hemispherical.	Spherical, H. U.		Lower Hemispherical H. U.
		In Lamp.	Power Factor Lamp.	In Arc.	Power Factor Arc.	Mechanism.	Op. Outer.	Clear Outer.	Clear Outer.	Op. Outer.	Clear Outer.	Clear Outer.
1	5.01	551		401		150	172	235 256*	332 362*	3.10	2.37 2.18*	1.66 1.52*
3	5.08	559		406		152	195	216	282	2.85	2.60	1.99
4	4.76	524		381		143	127	139	208	4.12	3.76	2.52
5	4.16†	458		333		125	154	174	221	2.96	2.63	2.07
7	4.76	524		381		143	203	233	317	2.63	2.20	1.65
9	4.84	532		387		145	182	226	281	2.83	2.38	1.89
10	4.99	549		399		150	202	242	309	2.74	2.24	1.77
12	4.87	536		390		146	178	195	230	3.05	2.66	2.33
	4.9	529		384		144	176	207	272	3.03	2.60	1.98
101	6.40	448	.63	340	.82	108	127	141	206	3.52	3.17	2.17
102	6.79	459	.61	375	.73	84	146	203 176†	236 266†	3.31	2.26 2.60†	1.94 1.72†
103	5.89	424	.65	344	.75	80	116	130	147	3.66	3.15	2.88
105	6.20	414	.61	382	.80	32	128	187	219	3.24	2 20	1.89
106	6.12	378	.56	298	.70	80	132	153 152†	169 254†	2.82	2.56 2.49†	2.23 1.48†
108	6.48	457	.64	383	.80	74.5	138	175	211	3 30	2.61	2.16
110	6.18	339	.49	276	.72	63	140*	126	143	2.41*	2.68	2.37
	6.29	417	.60	342	.76	74.5	130	159	190	3 31	2.66	2 23

* Condition of no outer globe. † Condition with shade on lamp.

NOTE—All marked values, not included in the mean.

	D.C.	A.C.
Clear outer.....	2.66	2.62
Opalescent Outer..	3.04	3.20

The difference is slightly in favor of the alternating-current lamp in the first case, and somewhat more in favor of the direct-current lamp in the second.

To compare the direct-current lamp with the alternating-current lamp on the basis of mean spherical intensity is not always fair. When an outer diffusing globe is used, this basis of comparison is correct enough, for the reason that the distribution of intensity is fairly constant in all directions, both for the direct and alternating-current types.

For out-door use, however, lamps will be provided with inner globes only, or clear outer globes, or shades, as the case may be. In any event, the upward luminous flux which passes the globes or shades is practically of no utility. Hence, for out-door use, the mean hemispherical intensity below a plane passing through the arc is a better basis for comparison.

Now the average direct-current lamp in this series of tests yields a mean hemispherical intensity of 273 H.U. with clear outer globe. The average alternating-current lamp yields but 190 H. U. This gives the former an advantage as a useful light source represented by the ration of 83.190 or 43.7 per cent. Moreover, the power required per unit intensity is in the two cases 1.97 watts and 2.19 watts per mean hemispherical H. U. So that not only the direct-current lamps with clear outer globe give a stronger mean intensity below the arc, but it does so at a higher efficiency. But it is wasteful to use an alternating-current lamp for street lighting without a shade or reflector. The tests on lamps 102 and 106 enable one to draw certain interesting comparisons. They give mean hemispherical intensities respectively of 266 and 254 H. U., or very nearly the same as the average direct-current lamp with clear outer. This yield is obtained at a power consumption of only 418 watts, which is 1.61 watts per H. U. This emphasizes the great importance of a shade on the alternating current lamp. Finally, we may compare this last result with the performance of direct-current lamp 1, *with no outer globe*, and no shade. Here the mean hemispherical intensity is 362 H. U., the power consumption 558 watts and the power per H.U. 1.54 watts. The conclusion based on this single comparison is that for street lighting the direct-current lamp without shade gives 39 per cent more useful light than the alternating-current lamp with shade and at slightly greater economy. Table XX gives the summarized results of the preceding investigations.

The report concludes with a description of certain preliminary experiments to determine the amount of light absorbed by the coating of ash formed on the inner globe of the enclosed arc, and the time law of its formation. But two representative examples of these measurements are here given. Fig. 5 refers to a direct-current lamp having a large inner globe of the closed-bottom type. Curve I' shrinks to

curve II' in 106 hours, and the absorption is 16.6 per cent.

In Fig. 5, which represents the result of a coating test on an alternating-current lamp, one finds the striking result of *more light with coating than without.* The absorption is 12.5 per cent. It is important here to remember that, with the arc at the top, the strong upper lobe of the distribution curve of the alternating arc is very much curtailed. Now, as the arc lowers, this lobe unfolds, as it were. In 70 hours' time, the coating has not formed with sufficient rapidity to offset this increase in luminous flux. Hence the result shown.

Report of the National Electric Light Association's Committee on Standard Rules.

Your committee on standard rules has continued the same line of policy during the past year as heretofore, *viz.,* to discountenance any changes in the National Code of Rules not absolutely necessary; but with the march of improvement in the electrical field some changes therein and additions thereto have been found necessary since the issue of 1897. Many of the changes made were suggested by the chairman of your committee, and others received his approval. The policy heretofore pursued by the insurance organization of sweeping out of existence thousands of dollars' worth of material that had been used previously with the sanction of insurance inspectors has been abandoned, and, while new and better devices and material are substituted, an opportunity is offered the manufacturer, dealer, contractor and station manager to sell and use the material and fixtures on their hands.

The thickness of interior conduit, lined or unlined, has been established, and commercial gas-pipe taken as the standard.

"Weatherproof" wire, so-called, is tabooed for interior construction unless covered with a slow-burning material.

A standard of thickness of insulation on wire, after a conference with the manufacturers, has been established.

The much-vexed question of the proper distance between fuse terminals has been determined, as well as the distance between fuse metals of opposite polarity. Switches are now being standardized as to the proper breaking distance between poles, etc.

The rules have been changed so as to permit the running of two more small motors in series multiple or multiple on constant potential circuits.

Rubber insulation is not now insisted on for flexible-cord pendants in dry places, but an elastic slow-burning material may be used.

Rule 40 has been so amended as to permit in dry places the use of a slow-burning insulation similar to what has been known in the past as "Underwriters."

(Signed) WILLIAM BROPHY.

THE INDEPENDENT TELEPHONE CONVENTION AT CLEVELAND.

RAILROAD AND HOTEL ARRANGEMENTS.

The attendance at the fourth annual convention of the Independent Telephone Association of the United States promises to be the largest in the history of the organization. The meeting is to be held in the city of Cleveland week after next, June 12, 13 and 14. Judge J. M. Thomas, president of the association, announces that the several passenger associations have granted a rate of one and one-third fare. This is on the certificate plan and all attendants should ask for a certificate of the station agent when purchasing a ticket to Cleveland, which, when signed by the secretary of the telephone association, will entitle the holder to the reduced rate of one-third on the return trip. The regular fare will be charged going to the convention. It is announced that the Cleveland hotels will make special rates for the delegates.

Mr. C. W. Wason, Electric Building, Cleveland, Ohio, chairman of the entertainment committee, is in charge of the exhibits and is receiving numerous requests for space not only from manufacturers of modern telephone apparatus but from a number of supply houses. It would seem that telephones and telephone apparatus of the latest and most ingenious pattern will be on view at Cleveland, and the enterprising men in the telephone operating field will find much to interest and instruct in this department.

The programme has not yet been completed, but it is expected that in addition to the discussion of a number of practical business questions, several technical papers will be presented.

An Electrical Outing.

Mr. James J. Nate, of the Standard Telephone and Electric Company, Madison, Wis., took a number of New York gentlemen home with him from the recent electric light convention, at Chicago, and entertained them at the Hoboken Club, on Lake Monona, where fishing and athletics were indulged in to a quiet extent. The most gamy fish were those of a night variety, known as "Kaps," and were caught at all hours, an average of about 15 by each sportsman. The occasion was one long to be remembered by the electrical men from the East. A slight accident resulted from one of the gentlemen treading on a fish and slipping to the bottom of a long pair of stairs, peeling off splinters and step edges, receiving birth marks and trade marks and landing in such shape at the bottom that the other men found great difficulty in not stepping on him in the dark. The quality and quantity of the fish, however, made amends for this slight mishap, and the departing guests were loud in their praises of the courtesy extended to them and of the beautiful surroundings of the Hoboken Club. President P. L. Spooner and Secretary E. W. Batchelder, of the Standard Telephone Company, vied with Mr. Nate in extending the courtesies of the beautiful city of Madison to the visitors.

Report of the National Electric Light Association's Committee on Freight Classification.

After numerous interviews and voluminous correspondence with the Central Traffic Association, at New York, we have succeeded in getting the same definite answers we got which were embodied in our report last year, namely, that the railroads did not see their way clear to harmonize the classification of electrical apparatus with that of other merchandise. They did not use these words, but they refused to take action, and the expression exactly covers the case. Your committee sees no possible hope for justice at the hands of the representatives of the railroad companies by any application of ours.

The Interstate Commerce Commission has expressed a willingness to listen to our statements, but has coupled with that expression the statement that it is powerless to do anything but make a recommendation; that it had no power to act or to compel the railroads to take action.

That a condition exists that is grossly unfair to the electrical interests is realized by every manufacturer. The only suggestion your committee has to offer is that the matter be taken up in the United States courts, and it recommends the employment of suitable counsel to this end as being the only possible remedy to-day. We are satisfied that the conclusions of the committee will justify the submitting of its case to any competent attorney; that is, that we have a clear case of unjust discrimination. If that is true, the association has every reason to take the step recommended by the committee. Necessarily, this will cost money, which we think will be forthcoming at the hands of the manufacturers, members of the association and others.

(Signed) JAMES I. AYER.

A Central Station Fire.

The power house of the electric light plant, at Chattanooga, Tenn., was partially destroyed by fire in the night of May 28, entailing a loss of about $10,000 and leaving the entire city in darkness the rest of the night. Assistant Engineer Melvin Dalmer, in attempting to get the telephone to give the alarm was probably fatally burned.

Electricity at the Carnegie Steel Works.

The Carnegie Steel Company has decided to make a complete change in the motive power system that operates its 30-inch mill of the Homestead Steel Works. Electricity is to take the place of steam in the operations of the shifting tables at the rolls, says a press telegram. This will take considerable time, as it means the replacing of this portion of the plant with entirely new machinery. The only machinery in the plant which will be operated by steam will be the big roll engine, and, if it is practicable, this engine will be replaced by electric power later. An engine similar in construction to that intended for the 40-inch mill will replace the one now in use. The cost of this engine will be $65,000. The total expenditure for improvements to this mill is estimated at about $200,000.

The introduction of electricity as the motive power for the shifting tables is an innovation at this plant. It is on these tables that all the big pieces of steel, such as angles, flat beams, etc., are carried to and from the rolls and shifted into the position required in rolling them into proper shapes. It will take considerable voltage to operate the heavy machinery, and a special electric plant will be erected in connection with the mill. The cost of this plant will be in addition to the $200,000 mentioned as the sum necessary for the improvement of the mill. Mr. William Bailey, chief engineer of the works, said that the changing of motive power and introduction of new machinery for that purpose would require considerable time, and that it would be four months at least before this plant would be ready to start under the new order of things.

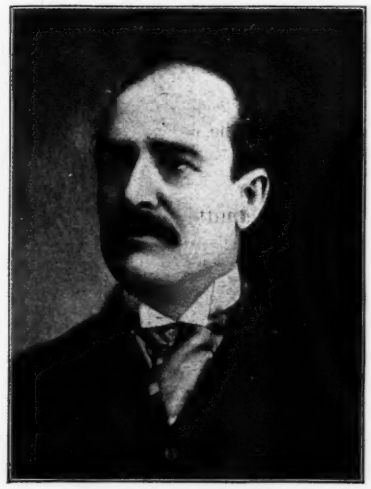
To Light the Thousand Islands.

The St. Lawrence International Electric Company, the electric lighting company recently formed at Alexandria Bay, N. Y., has been reorganized, its capital stock increased from $20,000 to $30,000, and the following officers elected: President, Hon. Jacob Amos, New York; vice-president, B. B. Taggart, Watertown; secretary, C. G. Wells, New York; treasurer, C. H. Remington. The company has just secured a contract to light the village of Alexandria Bay for five years. The lighting capacity of the plant will be increased at once to 6,000 lights, giving a total of 8,500 lights, and cables will be laid to the islands in the vicinity of the place, while the plant will be equipped with new boilers and apparatus.

John Millard Roach.

John M. Roach, president of the American Street Railway Association, has been elected to the presidency of the Union Traction Company, of Chicago. This promotion completes Mr. Roach's advance in eighteen years from the post of conductor on a horse-car, to that of the head of a system of 500 miles of electric and cable railway, including the line on which he began work. Mr. Jesse Spalding has been made chairman of the board of directors of the Union Traction Company, and will hereafter direct the finances of the company, leaving the entire operation of the system to Mr. Roach.

Mr. Roach was born in Noble County, Ohio, on June 30, 1851. At an early age



JOHN M. ROACH, PRESIDENT UNION TRACTION COMPANY, CHICAGO.

he went with his parents to Rockford, Ill., and later in life covered the entire western section of the country prospecting for gold. Arriving in Chicago in 1872, he entered the employ of the North Chicago Street Railway Company as a conductor. After serving four months in this position he was taken into the office and made cashier. From this time on he served in all the intermediate positions, until, as mentioned above, he has finally reached the top of the ladder. At the annual meeting of the American Street Railway Association, held at Chicago, last October, Mr. Roach was elected president. Mr. Roach is married and has one son. He is a member of the Union League, Marquette and Union Clubs, of Chicago.

The New York State Railroad Commission has given permission to the Lockport & Olcott Railway Company to construct and operate an electric road from Lockport to Olcott, Lake Ontario. The length of the road will be about 18 miles.

Wall Street and the Electrical Stock Market.

The dealings throughout the week were in an unusually limited volume, and chiefly for professional account. The week opened auspiciously, but the promises indicated were not carried out. The general situation, however, is still sound and tends toward prosperity and improvement, rather than to the contrary.

On the New York Stock Exchange, General Electric closed the week at 134 bid and 135 asked, a loss of 1 point for the week. Metropolitan Street Railway, of New York, closed at 154¼ bid and 154½ asked, a loss of ¾ point for the week. Third Avenue Railroad, of New York, closed at 114 bid and 114½ asked, a gain of 5½ points for the week. Brooklyn Rapid Transit closed at 71¼ bid and 71⅜ asked, a gain of ⅜ point for the week. Manhattan Railway, of New York, closed the week at 89¾ bid and 90¼ asked, a loss of 1¼ points for the week.

On the Boston exchange, American Bell Telephone closed at 308 bid and 309 asked, a gain of four points in the bid price for the week. Erie Telephone closed at 101 bid and 102 asked, a loss of 1 point for the week.

On the Philadelphia exchange, Electric Storage Battery was not quoted. Union Traction closed at 37 bid and 37¼ asked, a loss of 1 point for the week. Electric Company of America closed at 11 bid and 11⅛ asked, a gain of 2⅛ points for the week.

On the curb, or outside market, in New York, Electric Vehicle closed at 25 bid and 30 asked, indicating no change for the week. Electric Boat closed at 19 bid and 21 asked, a loss of 1½ points for the week.

Wall street, May 26.

Municipalism and Gastritis.

[*From the Birmingham (Ala.) News.*]

Mayor W. M. Drennen, with the members of the aldermanic board and city officials, who went down to Jacksonville to investigate the lighting plant owned by that municipality, returned to Birmingham this forenoon. Mr. George Eustis, city treasurer, took very ill on the trip, having a hard spell of fever and stomach troubles. He was abed almost through the entire trip, and looked badly on alighting from the train. He was escorted to a hack and sent to his home immediately and a physician sent for.

The gentlemen who were on the trip say they saw considerable favorable towards the movement looking to the city owning its own lighting arrangements.

Relief Valves in Water Power Plants.

One of the most difficult problems connected with delivering water through a long pipe is the prevention of what is commonly called water hammer. Water is heavy and practically incompressible. It is, of course, impossible to arrest the motion of a heavy incompressible body suddenly without exerting considerable pressure against it. The amount of pressure required to stop a body in a given time, when moving at a given velocity, is just the same as the pressure required to give the same body the same velocity in the same time.

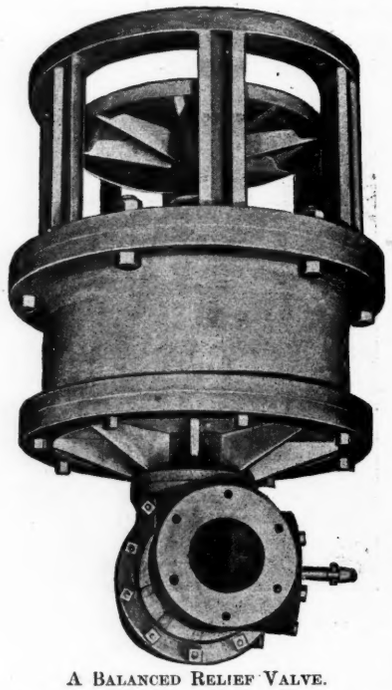
The above facts are ordinarily expressed by the equation $F = (MV) \div T$ where F is the force in pounds; V is velocity in feet per second; M is the mass —the weight divided by 32.17; and T is the time in seconds in which the motion is arrested. It will be noticed from the above equation that the shorter the time in which the velocity of the body is arrested, the greater will become the force necessary to stop it. It is for this reason that you may cut off water by closing a valve gradually without increasing the pressure much; but if you close the valve quickly the pressure becomes very great.

It would now seem as though it ought to be a very easy matter to calculate just how much pressure would be developed upon shutting a valve in any given time; but this is not the case, for the reason that while the valve is being closed the motion of the water is not being arrested at a fixed rate. At first the water motion is arrested but very little, but, as the valve becomes more and more closed, the water velocity becomes arrested faster and faster until at the moment when the valve is finally closed the water is brought to a sudden stop with a very great increase of pressure.

The laws governing the flow of water through crooked and irregular orifices of varying sizes are not well understood, and there have not yet been a sufficient number of experiments to establish an empirical formula.

In order to govern the speed of a water wheel accurately when the load varies rapidly, it is necessary to open and close the gates with great promptness so as to vary the amount of water which flows through the wheel to correspond to the load. If the water wheel is located at the end of a feed pipe the velocity of the water therein contained must be varied to correspond to the variations in load; and every time the load decreases and the water-wheel gates close more or less the water pressure will increase for the reasons above stated.

It is now very important to notice that the water hammer effect becomes a disturbing element in speed regulation in proportion as it is a large per cent of the working pressure at the water wheels. For example: Assume a vertical pipe 100 feet high with a water wheel at its lower end. The static pressure would be 43 pounds per square inch, and the working pressure might easily be 42 pounds per square inch. Now assume a feed pipe 100 feet long, but so nearly level that there is only 10 feet of head on the water



A Balanced Relief Valve.

wheel. Assuming the size of pipe and water velocity to be the same, the frictional loss would be the same, for it is independent of pressure. Hence, the static head in the latter case would be 4.3 pounds per square inch, and the working pressure would be 3.3 per square inch.

Now assume that by arresting the two water columns above named a certain amount, by suddenly partly closing the gates of the water wheels, a water hammer pressure of only 1.65 pounds per square inch is produced. Then in the case of the vertical pipe the increased pressure due to water hammer is only 3.9 per cent of the working pressure; while in the case of the nearly horizontal pipe the increased pressure due to the same water hammer is 50 per cent of the working pressure. In the first case it would not interfere with obtaining good speed regulation; in the latter case good speed regulation would be simply impossible.

It is thus seen that where the feed pipe is more or less inclined from the vertical we soon reach a limit of length beyond which speed regulation can not be obtained unless we install some sort of valve at the water-wheel case, which will open when the water wheel gates close and allow the water to escape until the pressure comes back to normal. Many kinds of relief valves have been designed, in which the water pressure is opposed by springs or weights, but it has been found in practice that if such valves are set to open on a small increase of pressure the pressure will run up greatly in proportion to the amount of water the valve is called upon to vent. There are good theoretical reasons why this must be so. Therefore, such valves are claimed to be of little or no use in plants where good speed regulation must be obtained.

The valve shown in the accompanying illustration, and which is made by the Lombard Water-Wheel Governor Company, of Boston, is claimed to be free from all the above objections. In it the water pressure against the valve disk is opposed by the static water pressure at the point where the valve is attached to the flume or water-wheel case, and as long as the working pressure does not exceed the static pressure the valve will remain closed; but if the flume pressure at any moment exceeds the normal pressure even by a fraction of a pound to the square inch, the valve will instantly open and vent water until the pressure is back to normal. It will open with equal promptness whether it is called upon to vent a very small amount of water or the full amount which can flow through it when wide open. It has adjustments so that it can be made to open at any increase of pressure which may be desired. Its interior surfaces and curves are carefully designed, so that it has a very large coefficient of discharge.

The cut shows the valve partly open. The upper flange is bolted directly to a flanged branch from the flume or wheel case. The valve may be installed vertically, as shown, or horizontally.

This valve has been installed under the most difficult conditions, and when used in connection with Lombard governors has enabled good speed regulation to be obtained in plants which, it is said, were utterly ungovernable without it.

Winnipeg, Man.—The Bell Telephone Company will spend $25,000 this season in building a long-distance system to Manitoba.

A Regulator for Single Incandescent Lamps.

The one special disadvantage of the incandescent electric light, as compared with gas, has been that it must be at full brilliancy or be wholly extinguished, whereas the gas jet can be turned up and down to give any degree of light desired. This is very important in the vestibules, halls, bath rooms, passageways and bed rooms of private houses; in the bed rooms and corridors of hotels; in the wards and private rooms of hospitals, and in the staterooms of steamships, in all of which considerations of comfort and economy render very desirable a light which can be toned down to any point desired. A patent has just been issued to the Electric Regulator Company, of 26 Cortlandt street, New York city, to meet this need.

FIG. 1.—SIDE WALL BRACKET EQUIPPED WITH INCANDESCENT LAMP REGULATOR.

FIG. 2.—CANOPY PARTLY OPEN, SHOWING CONSTRUCTION OF INCANDESCENT LAMP REGULATOR.

The device consists of a small rheostat located in the canopy of a side wall bracket or of a fixture depending from the ceiling, or it may be used in a special separate switch located in any convenient place, and connected with a lamp on the ceiling or elsewhere, as in halls or vestibules, or in the staterooms of steamers.

Fig. 1 shows an ordinary side wall combination bracket with the regulator placed inside, governed by an ordinary key. By the operation of the hand, as indicated in the illustration, the regulator is operated independently of the regular lamp socket key. Fig. 2 shows the canopy held half open, in the act of putting it in place, and discloses the interior construction. It will be seen that it consists of a resistance tube, surrounding the standard of the fixture, with a switch on the under side connected with the different steps of resistance. Both the switch and the tube are mounted on a base, which serves to support them, and has legs by which it can be fastened to the wall and the canopy also be held in place. When the key is turned the light is reduced by several steps to the merest glimmer, with a saving of current from one-third on the first step to three-fourths on the last, where it gives the faintest possible light without danger of being extinguished, as so often happens with the deadly low-turned gas jet.

The switch deserves particular notice. It consists of alternate layers of metal and mica riveted together. From the metal plates fingers are turned up and arranged in a circular path, so as to be readily touched by a contact spring attached to the key-shaft and revolved by the movement of the key. The whole device is especially strong and compact, and furnishes a cheap and efficient means of controlling the steps of a small rheostat for giving graduations of electric current for either light, heat or power.

OUR CANADIAN LETTER.

QUEBEC, QUE.—The city will purchase an electric street sprinkler.

HULL, QUE.—The contract for an electric light plant will be let in a few days.

PORTAGE-LA-PRAIRIE, MAN.—The Central Electric Company will remodel their plant.

WALLACEBURG, ONT. — An automatic fire alarm bell will be purchased by the council.

CANNINGTON, ONT.—An electrical engineer will be engaged to value the electric plant.

DESERONTO, ONT.—The Thousand Island Railway Company will generate and use electricity.

EAST TORONTO, ONT.—The council has decided to invite tenders for a system of electric lighting.

SANDYCOL, ONT.—The Metropolitan Railway Company will extend their road to this place and Craigvale.

HALIFAX, N. S.—Extensive improvements will be made to the telephone system, at a cost of $40,000.

OTTAWA, ONT.—The Ottawa Electric Company will rebuild their power houses and equip them with modern plants.

NEW WESTMINSTER, B. C.—The British Columbia Electric Tramway Company will extend their line to Sapperton.

MONTREAL, QUE.—The Chambly Water and Power Company purpose developing additional power at Ste. Therese Rapids.

HAMILTON, ONT. — John Patterson states that the final survey of the electric railway from Preston to Berlin is being made.

MONTREAL, QUE.—The Park and Ferries Committee of the city council have decided to invite plans for a new incline railway.

MUNAY BAY, QUE.—The Labrador Electric and Pulp Company is proceeding with its works with a view to supplying electric light.

SMITH'S FALLS, ONT.—The Smith's Falls Electric Light Company will build an addition to their power house and install new apparatus.

RENFREW, ONT.—Thomas Low is endeavoring to float a company to develop the water power on the Bonnechere River for industrial purposes.

SHAWVILLE, QUE. — The Bell Telephone Company are considering a proposal to extend their system throughout the county of Pontiac.

SUNDERLAND, ONT.—The Sunderland Electric Power Company has been incorporated to supply light and power. James McDermott and Henry Baldwin are the directors.

KINNEAR'S MILLS, QUE.—Tenders are asked for construction of telephone lines from Thetford Mines to this place, a distance of 12 miles. W. Waicup, secretary-treasurer, Kinnear's Mills Telephone Company.

LETETE, N. B. — The Marine Telephone Company is seeking incorporation to build a telephone line between St. George, Back Bay, Fair Haven and other points. David Kelly and Stephen Dick, of this place, are interested.

PORT ARTHUR, ONT.—Messrs. D. S. Wegg and G. H. Pope, of Chicago, have been incorporated as the Anglo-American Power Company, with a capital of $5,000,000. The company will acquire the Jension water powers, on the Kaministiqua River.

J. A. C.

Montreal, May 28.

TELEPHONE AND TELEGRAPH

The seventeenth annual report, as of January, 1900, of the Erie Telegraph and Telephone Company, has been issued in the form of a quarto booklet.

The Wilton (N. H.) Telephone Company has been incorporated with a capital stock of $2,000. The incorporators are: George E. Bales, E. E. Higgins, W. I. Durgin, Joshua F. Frie and H. L. Emerson.

The Secretary of State of Tennessee has granted a charter to the Roane County Telephone Company. The capital stock is $2,500, and the incorporators are: J. A. Erwin, J. E. George, T. L. Peterman, T. A. Wright and G. W. Cooper.

The stockholders of the Rochester, N. Y., District Telephone Company held their annual meeting recently. The officers and directors elected are as follows: President, S. B. Gifford; vice-president, C. A. Tinker; secretary and treasurer, G. D. Butler; directors: J. C. Kalbfleisch and Erickson Perkins.

The Southern New England Telephone Company has announced that it will make a new issue of five per cent first mortgage bonds to the amount of $100,000. It is stated by President Tyler that the issue is made in the regular course of business and has no special significance. The growth of the company and enlargement of its plant necessitate the new bonds.

The Local Telephone Company, of Martin, Tenn., has made a remarkable showing at the end of its first year of operation. Arrangements are under way for the connection of every town in Weakly County. The whole amount of stock is owned by home citizens and during its first year the company has earned a dividend of something more than 20 per cent.

The Citizens' Telephone and Message Company, of Fostoria, Ohio, has elected W. C. Beckwith, of Fostoria, president; J. B. Hoge, of Cleveland, vice-president; T. D. Stevenson, of Fostoria, treasurer; H. T. Treaman, of Fostoria, secretary; Jesse Stephens, of Fostoria, counsel; W. S. Wagner, of Tiffin, superintendent, and J. C. Rhodes, of Fostoria, manager. The authorized capital stock was increased to $50,000.

The New Prague, Minn., Telephone Company has filed papers of incorporation with the Secretary of State and paid the fee on a capitalization of $10,000. The new company proposes to operate a telephone system in towns of less than 20,000 through Scott, Le Seuer and Rice counties, with headquarters at New Prague. S. A. Vopatek, J. F. Barta, M. Rybak, all of New Prague, constitute the board of directors.

An independent telephone company has purchased the existing rights and line of the Saco & Biddeford, Me., Telephone and Telegraph Company, and proposes to begin business in Saco, Biddeford, Old Orchard and Biddeford Pool in the near future. The new company is composed of: George P. West, of Portland; Carlos Heard, E. W. Staples, Jere G. Shaw, Charles H. Prescott and Charles E. Atwood, of Biddeford; Hampden Fairfield, Luther R. Moore, A. G. Prentiss and Herbert R. Jordan, of Saco.

At the annual dinner of the Transportation Club, of which Senator Chauncey Depew is president, held recently in New York city, at the Manhattan Hotel, a peculiar feat of telephony was performed. The senator was not able to be at the dinner, being detained in Washington, but delivered a short address to the club members present by means of the telephone. Sixty receiving instruments were distributed among the guests. All of the company greatly enjoyed the senator's remarks made 230 miles away. As there were 100 diners and only 60 telephones, the senator was compelled to repeat his address, each time to a new audience.

The Association of Independent Telephone Companies of Indiana, which held its fourth annual meeting in Indianapolis recently, elected the following officers for the year: President, John McGregor, Madison; vice-president, Charles M. Zion, Lebanon; secretary and treasurer, Harry B. Gates, Indianapolis; executive committee: John McGregor, Madison; Charles M. Zion, Lebanon; Harry B. Gates, Indianapolis; L. A. Frazee, Connersville; Hugh Dougherty, Bluffton; A. F. Ramsey, Crawfordsville; G. W. Beers, Ft. Wayne. It was reported by the members of the association that there are 160 independent exchanges in the state, and 40,000 telephones in use, with 7,000 miles of toll wire.

The stockholders of the Citizens' Telephone Company, of Columbia, Tenn., held their annual meeting a few days ago. The financial report of the company was satisfactory. The report showed further that the Citizens' Company is increasing in the number of subscribers, the number of telephones in use at present being 494. The following directors were elected: W. M. Cheairs, F. P. Brumbach, James Smiser, John C. Sowell, John Cecil, A. B. Rains, Flem Thomas, Emmett Hogue, R. Gooch, A. J. Timmons, W. B. Greenlow, R. S. Perry, Geo. W. Killebrew, Nelse Woolard, C. C. Collins, Willis Jones, R. C. Church, Ed. Kendle, J. L. Hulton, A. J. Porter and J. A. Bostick. At the directors meeting A. J. Porter was elected president and George W. Killebrew vice-president.

It is stated that the Illinois Telephone and Telegraph Company, of Chicago, is expecting the addition to its capital of a considerable amount of eastern money. There is good authority for the statement that two sets of purchasers have been making overtures for the franchise, but in either case it is claimed that the opposition to the American Bell Company will be continued, while officers of the company have denied that a sale of the franchise is contemplated, there is no attempt to deny steps toward reorganization, and it is reported that the Telephone, Telegraph and Cable Company of America is actively interested in securing the control of the Chicago opposition franchise. This franchise derives special value from the fact that already more than 2,000 feet of tunnels, five by seven feet in size, have been constructed under it. It is stated that this franchise was the only one of metropolitan importance, except that of the Kinloch Telephone Company, of St. Louis, which has been absorbed by an eastern syndicate.

The independent telephone people, of West Texas, met at Abilene, Tex., on May 17, and organized an association called the West Texas Telephone Association. The objects are the acquisition of experimental, statistical, scientific and practical knowledge of all matters relating to the construction, operation and maintenance of telephone exchanges and the advancement of their interests and also the establishment and maintenance of a spirit of fraternity between the members of the association by social intercourse and friendly exchange of information and ideas and the extension of more cordial and friendly relations between members and their patrons. Officers were elected for the coming year as follows: W. C. Roberts, Abilene, president; C. H. Woodward, Brownwood, vice-president; W. M. Brooke, Dallas, secretary, and W. A. McSpadden, Cisco, treasurer. A great many points of interest were brought up and discussed during the day and the meeting adjourned. The next meeting will be held at Abilene, Tex., August 8, 1900.

Some New Types of Enclosed Arc Lamps.

The enclosed arc lamps shown in the accompanying illustrations have been designed by the General Incandescent Arc Light Company, of New York city, to operate in series on any direct-current constant potential circuit of 200 volts or above, the only limitation being that each lamp shall have at least 90 volts and not more than 125 volts at the terminals. The most customary conditions under which this lamp is operated are two in series on 200 to 250 volt light and power circuits, and five in series on 450 to 600 volt power and railway circuits.

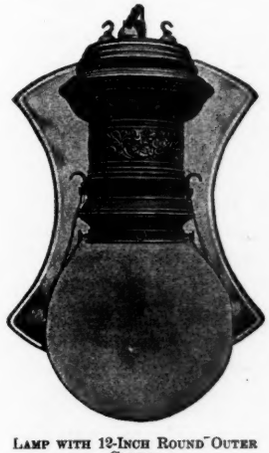
The manufacturers have aimed to fill a long-felt want, especially among street railway companies, for a thoroughly reliable multiple series lamp, simple in design, yet at the same time thoroughly substantial and efficient, giving 150 hours' life with one 12 inch by one-half inch solid carbon.

The great difficulty with multiple series lamps, which is necessarily magnified as the number of lamps in the series is increased has been to secure their perfect regulation and avoid the lamps "see-sawing" or "robbing each other" of their share of the potential of the circuit. This difficulty the General Incandescent Arc Light Company claims to have entirely overcome by using the differential method of regulation, and by giving the most careful attention to the design of the shunt and series winding, and to the magnetic circuit of the lamp. The results obtained have been extremely satisfactory.

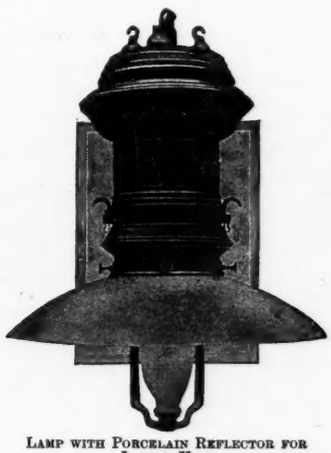
Each lamp is equipped with an equalizing resistance, which by means of a carefully designed cutout is automatically cut into the circuit in case the carbon should stick or burn out, thus balancing the circuit and allowing the remaining lamps in the series to continue burning without interruption. In the event of any lamp needing trimming or adjustment, a hand switch is provided on each lamp, which cuts in the equalizing resistance, allowing the lamp to be trimmed or adjusted without affecting any of the other lamps in the series. By the use of carefully designed windings, which are of larger cross-section than ordinarily used, and an automatic cutout, it is practically impossible to burn out the shunt windings.

A distinctive feature of the lamp is a new shadowless, and at the same time substantial trimming device, on the design and perfection of which a great amount of time has been spent. The device presents the least possible obstruction to the light and necessarily casts the minimum shadow. By pulling the trimming device down against the tension of the springs shown, it may, on account of it being hinged, be moved backward or forward, allowing the globe to be easily removed and giving full access to the carbon-holders for retrimming. It will also be noticed from the illustrations that just above the inner globe the lamp is equipped with a porcelain lined metal reflector, and much of the light from the arc otherwise diffused is reflected down, thus increasing the useful illuminating power of the lamp.

The length of lamp with globe is 25 inches; with reflector, only 23 inches.



LAMP WITH 12-INCH ROUND OUTER GLOBE.



LAMP WITH PORCELAIN REFLECTOR FOR INDOOR USE.

LAMP WITH OUTER GLOBE AND WHITE ENAMEL METAL REFLECTOR.

LAMP WITH ROUND GLOBE.

FIGS. 1, 2, 3 and 4—SOME NEW TYPES OF ENCLOSED ARC LAMPS.

ELECTRIC LIGHTING

The Fulton County, N. Y., Gas and Electric Light Company has been incorporated with a capital of $1,500,000.

The city council of Hastings, Neb., met in special session recently and discussed the erection of an electric light plant there for which $20,000 in bonds was recently voted. The council decided to secure the services of Owen Ford, of St. Louis, an electrical engineer, to assist in putting in the plant.

The Town Board of Islip, L. I., has granted a franchise for 50 years to the Sayville Electric Light Company, and also granted the application for a lighting district in the village of Sayville. A tract of land north of the railroad was recently purchased by the company from Israel S. Green and a side track is to be run into the grounds by the railroad company.

Negotiations between the Central New York Electric Light and Power Company and the village trustees of Skaneateles, for the purchase of the company's electric light plant within the village have been completed and at a conference the offer of the light company was accepted and its property, rights and franchises will be transferred to the village. The price paid was $3,500.

The stockholders of the Freehold, N. J., Gas and Electric Light companies have elected the following officers: President, Holmes V. M. Dennis; vice-president, D. V. Perrine; secretary and treasurer, Charles H. Butcher. Directors: Lee Deedmeyer, Holmes V. M. Dennis, Charles H. Butcher, Samuel R. Forman and D. V. Perrine.

The Consolidated Electric Company, of Philadelphia, has closed a deal for the purchase of the electric plants at Franklin and Oil City, Pa., and is negotiating for the purchase of the Smithman Street Railway in Oil City. The purchase or lease of the Smithman line is said to be but a part of a great scheme to connect various cities in Western Pennsylvania by a trolley system that will cover a hundred miles.

INDUSTRIAL NOTES

The Shelby Electric Company, Shelby, Ohio, reports a most busy and successful season in its incandescent lamp factory.

The New York & Ohio Company, Warren, Ohio, has issued a "high art" calendar for June, calling attention to the merits of Packard incandescent lamps and transformers.

The Sprague Electric Company, 527 West Thirty-fourth street, has prepared a handsomely illustrated bulletin describing the company's safety system of electric water-tight doors.

C. W. Hunt Company, 45 Broadway, New York city, describe industrial railways for manufacturing establishments in catalogue No. 002, which may be obtained free on request.

No. 65 is the catalogue describing and illustrating the electric sprinkling cars manufactured by the J. G. Brill Company, Philadelphia, Pa. The catalogue may be obtained free on request.

Mr. B. W. Grist, formerly with the Pennsylvania Iron Works, has been appointed general superintendent of Riehle Brothers Testing Machine Company, 1424 North Ninth street, Philadelphia.

The New England Engineering Company, Waterbury, Ct., is in a position to furnish genuine Magnolia metal at a special quotation of 18 cents per pound in any quantities f. o. b. cars at Waterbury, Ct.

Mr. J. H. Carson, representing the Sterling-Meaker Company, of New York, attended the National Electric Light Association Convention at Chicago last week, and met a large number of electric railway friends who were also present.

The Western Electric Company, Chicago, has just issued two handsomely illustrated bulletins. One describes a complete line of fire alarm and police telegraph apparatus, and the other is devoted to the company's series enclosed alternating arc lighting system.

The Western Electrical Supply Company, St. Louis, Mo., in its department for central station equipments carries the Adams-Bagnall solid copper enclosed arc lamps for direct and alternating current, and the Maloney transformer, claimed to be the latest and best transformer made.

The Electric Appliance Company, Chicago, have been appointed agents for the celebrated line of annunciators manufactured by Partrick, Carter & Wilkins, of Philadelphia. The Chicago depot will prove a convenience for the Southern and Western trade, insuring quick shipments.

The Montauk Multiphase Cable Company, 100 Broadway, New York city, reports that numerous of its customers, such as large department stores, are using their private fire alarm systems, equipped with Montauk fire detective cable, to call out their private fire departments for practice.

The H. B. Camp Company, Aultman, Ohio, will send descriptive literature to those making application of the Camp vitrified clay conduit for underground telephone and telegraph electric light wires. This conduit has been used for years by many of the best electrical engineers.

The Emerson Electric Manufacturing Company, St. Louis, Mo., has issued bulletins describing its alternating-current pumping outfits and its dental and surgical air pump outfits. This company's complete line of alternating-current fans can be delivered promptly from either St. Louis or New York city stock.

The Century Motor Vehicle Company, of Syracuse, N. Y., has published a beautiful and satisfactory catalogue illustrating its various automobiles of steam, electric and gasoline driven types. The peculiarity of these vehicles resides in the transmission device between the motor and wheels and in the suspension of the motor. The designs are marked by unusually long wheel bases, insuring steadiness of motion.

The Bristol Company, Waterbury, Ct., has just issued a new partial list of Bristol's recording instruments for pressure, temperature and electricity. Although the list contains 208 different varieties of instruments this well-known company is continually making additions to meet new demands. The company's business is enjoying a rapid growth and its number of satisfied customers becomes larger every day.

Mr. J. M. Denniston, Chicago manager for the Eddy Electric Manufacturing Company, of Windsor, Ct., looked after the interests of his company at the Chicago convention of the National Electric Light Association. Eddy dynamos and motors were among the first manufactured in the United States, and the popularity they achieved in the early days of the art is still evidenced by the great and increasing number in use.

The Long Island Railroad Company, through Mr. H. B. Fullerton, special agent of the passenger department, has issued a beautiful booklet entitled "Unique Long Island." It contains 96 pages of half-tone reproductions from photographs taken on the island. There is no advertising matter whatever with the exception of the title page, the pictures themselves being relied upon to show the attractions of New York's greatest pleasure grounds.

The Frank S. De Ronde Company, 54 John street, New York, is just introducing a new cold water paint for exterior and interior painting known as "Lythite." This preparation is claimed to be a most satisfactory substitute for oil paint at about half the cost, and is not a kalsomine. It is put up as a dry powder in white and many colors, and is ready for use by adding water. The company is desirous of sending samples to those who are interested.

The United States Battery Company, 253 Broadway, New York, has now established the following branches: 9 Cornhill, Boston; 34 West Monroe street, Chicago; 552 State street, Brooklyn, N. Y., and arrangements have also been made whereby its portable storage batteries, portable battery lamps of various types, and battery specialties, are now carried in stock by electrical supply companies all over the United States.

The Kentucky Electrical Company, Owensbury, Ky., manufacturers of the Kentucky incandescent lamp, are represented by John W. Brooks, who is the company's western sales agent, with office at 605 Plymouth Building, Chicago, Ill. This company asserts that its lamp accomplishes unusual results in giving a pure white light and in maintaining both candle-power and efficiency without blackening. In producing this lamp, Libby glass is used on the individual exhaustion process.

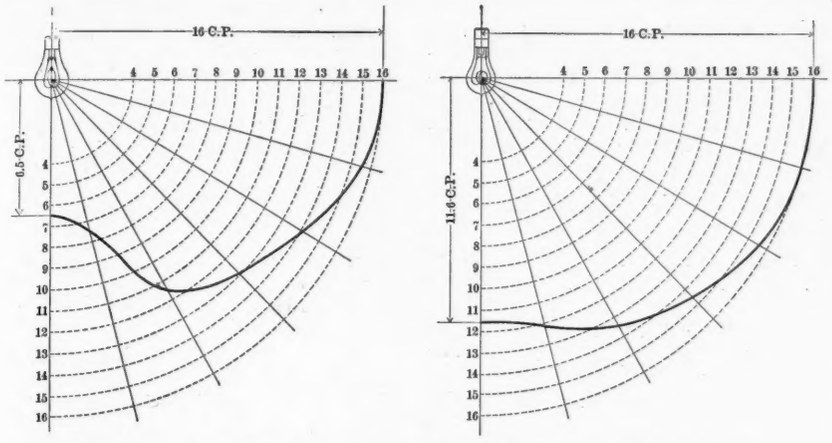
The Federal Battery Company, of New York, announces that it has made arrangements with the Frank S. De Ronde Company, of New York city, and 48 North Fourth street, Philadelphia, to carry Federal salt and Federalite in quantity, as a convenience to the wholesale trade in the following territory: Delaware, Maryland, eastern Pennsylvania, lower New Jersey, and District of Columbia. The latter company is now prepared to supply the wholesale trade in this territory at exactly the same rates as the Federal Battery Company.

The Brown-Bierce Company, Dayton, Ohio, during the past year has made a specialty of making half-tone engravings of electrical machinery and mechanical parts, and the company now has a large number of the most representative manufacturing electrical companies as its customers. This character of engraving requires a special aptitude, as often in a case of mechanical illustration done in half-tone, the elements of a piece of apparatus may be entirely lost in the picture through poor engraving, and it is just to this particular branch that this company has given much thought.

The Consumers' Carbon Company, of Lancaster, Ohio, is busily at work upon its immense new factory which is situated in a natural gas territory. The company owns its gas wells and expects to employ about 160 men, the works having a capacity of 150,000 carbons daily. The buildings are being constructed of brick and iron, making them practically fire-proof. For the most part they are only one story high and contain 50,000 square feet of floor space, occupying a property of five acres which will allow for considerable future extension. The new plant will be under the supervision of Mr. Edmund Dickey, its general manager, who was formerly secretary and manager of the American Carbon Company, at Noblesville, Ind. The company is already in a position to make contracts for delivery in November, 1900.

A New Departure in Incandescent Lamp Manufacture.

There is hardly any subject that has been discussed with more acrimony and at greater length than the method of rating and testing the candle-power of incandescent lamps. As everyone knows, the amount of light radiated from an incandescent lamp varies in different planes to a very considerable degree. In the ordinary horseshoe filament lamp, for example, the difference between the light radiated in the path of the lamp's axis is not much more than a third of that radiated in a plane 90 degrees distant. Naturally in the direction of the base of the lamp no light is radiated at all since this part casts a shadow.



FIGS. 1 AND 2.—A NEW DEPARTURE IN INCANDESCENT LAMP MANUFACTURE—CURVES OF LIGHT DISTRIBUTION.

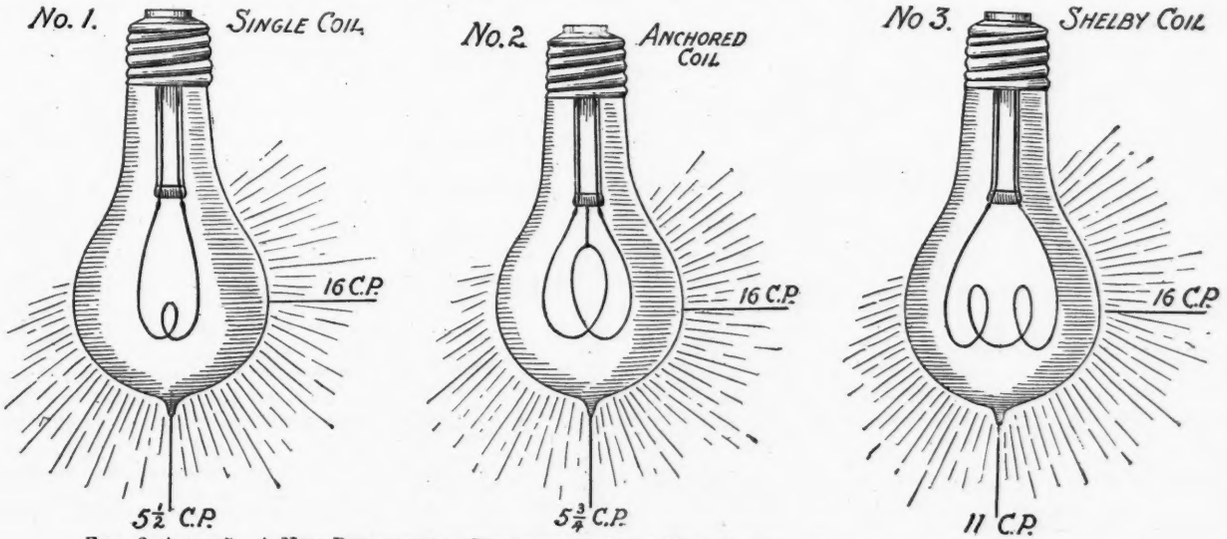
It was not until the invention of the incandescent lamp that a source of light was available that cast no shadow beneath it. The pine knot, the tallow candle, the kerosene lamp, all sorts and kinds of gas burners, are instruments employing flames, and the flames go up from their sources which are underneath them, and hence cast shadows downward. Indeed, before the invention of the incandescent lamp no one thought of calculating light efficiency or candle-power with reference to the illumination of objects beneath the light itself, but it was taken for granted and never contradicted that the proper direction in which to measure such candle-power was the horizontal.

So well was it understood that the light that went upward was lost and that which went downward was negligible, that all manners of illumination were based upon a maximum radiation of light in a horizontal direction. When the incandescent light was introduced, the early makers seemed to have fallen directly into accord with this accepted method and they proceeded to make incandescent lamps in such a way that they would distribute the largest number of light units on the horizontal plane. Indeed, some of the early electric light fixtures are arranged with the socket below the lamp, the lamp standing up straight. It did not take long, however, to see the advantage of turning the lamp over and letting it hang bulb downward which everyone concedes to be the proper and reasonable method of installing incandescent lamps.

The present custom in measuring incandescent lamps is to apply the photometer at an angle of 45 degrees with the axis of the lamp, while the lamp itself is revolving at about 185 times per minute. As no lamp has ever been used in practice hung under such conditions it does seem a little strange that this should be the accepted method of measurement.

The idea of constructing a lamp which would radiate a large portion of its candle-power vertically downward when hung in the usual vertical position occurred to the Shelby Electric Company, of Shelby, Ohio, which is a very large manufacturer of incandescent lamps. After some experimenting, this company succeeded in constructing a lamp which throws its light downward to a remarkable degree and shows some curious figures in comparison with standard types.

The method of constructing the lamp is to use a triple coil filament which is well shown in the sketch, Fig. 5. Figs. 1 and 2 illustrate curves of light distribution, Fig. 1 being that of an ordinary single coil anchored filament lamp and Fig. 2 that of the Shelby form triple coil filament. It will be noticed that the horizontal measurement of both lamps is 16 candle power. At the 45 degree plane the anchored filament shows 13 candle-power and the triple coil 14½. Directly under the lamp, however, the illumination from the anchored filament is only 6½ candle-power, while that from the triple coil filament is 11.6 candle-power, or nearly twice as much. To attain so valuable and interesting a result with such a simple means is somewhat remarkable.



FIGS. 3, 4 AND 5.—A NEW DEPARTURE IN INCANDESCENT LAMP MANUFACTURE—COMPARISON OF VERTICAL INTENSITY OF INCANDESCENT LAMPS.

CORPORATION NEWS

HALIFAX, N. S.—The city council is at present considering the installation of an electric light plant.

BEDFORD, QUE.—The council is considering the question of lighting the streets by electricity.

PORT MAITLAND, ONT.—Negotiations are in progress with a view of installing an electric light plant here.

ST. MARY'S, ONT.—The by-law to take over the electric light plant will be voted on by the ratepayers on July 21.

WOODSTOCK, ONT.—The gas, electric light and waterworks plants will be united and a large power plant will be established.

NEW YORK CITY—Federal Electric Company, of New York city, has been incorporated. Capital $1,000; directors: Benjamin Blum and Nathan Blum, New York city.

CANASTOTA, N. Y.—The Farmers' Telephone Company, of Madison and Oneida counties. Capital, $1,000; directors: Milton Jennings, of Canastota, and R. D. Button, of Cottons, Madison County.

STONE BLUFF, IND.—The Shawnee Telephone Company, of Stone Bluff, Fountain County, capital stock, $3,000, has been incorporated. The names of 25 people are given as the incorporators.

DOVER, DEL.—Mexican Gas Construction Company has been incorporated to build and equip refrigerating plants and gas, electric light, heat and other apparatus in the Mexican States; capital, $100,000.

ST. JOHN, N. B.—The city council has decided to invite tenders up to June 30 for lighting the city for a term of five years. A committee will also report on the advisability of installing an electric light plant (municipal).

NEW YORK CITY—The Carleton Electric Company has been formed to carry on the business of electricians; capital, $100,000; directors: Henry Guy Carleton, Charles E. Phelps, New York city; John C. Osgood, Denver, Colo.

MAXWELL, IND.—The Citizens' Telephone Company, of Hancock County, with headquarters at Maxwell, has been incorporated. Capital stock, $10,000; directors: Vard Finnell, T. Thomas, B. Piper, Charles Kingen, Thomas A. Seaman and Eli Hagan.

SOUTH BEND, IND.—The Miller-Knoblock Electric Manufacturing Company has received a charter. It is to be located in St. Joseph County. Capital stock, $125,000; directors: John C. Knoblock, Otto M. Knoklock, William H. Miller and Horace G. Miller.

NEW YORK CITY—The Federal Electric Company, of New York city, has been organized. This company is formed for the purpose of manufacturing motors, dynamos, machinery, telegraph and electric supplies. The capital stock is placed at $1,000.

SPRINGFIELD, MASS.—The Springfield Electrical Manufacturing Company has been organized at Saco, Me., with a capital of $10,000, of which $3,000 is paid in. The president is Herbert E. Bosworth and the treasurer Bentley C. Starr, both of Springfield, Mass.

TOLEDO, OHIO—The Valley Electric and Power Company, which is now erecting its plant in this city, has received incorporation papers. The incorporators are: W. B. Taylor, G. K. Detwiler, A. K. Detwiler, H. E. King and T. H. Tracy. The capital stock is $100,000.

ELMIRA, N. Y.—The Elmira Water-Light Company, of Elmira, has been chartered to furnish light, heat or power for Elmira and for the towns of Elmira and Horseheads, and other towns in Chemung County. Capital, $1,000,000; directors: Charles F. Uebelacker, Ross M. Lovell and E. Watson Personius.

POUGHKEEPSIE, N. Y.—The Empire Lighting Company, of Poughkeepsie, has been incorporated to manufacture gas and electricity for use in Poughkeepsie and villages and towns in Dutchess County. Capital, $100,000; directors: F. A. Stratton and Charles H. Werner, New York city, and L. B. Grant, Brooklyn.

NEW YORK CITY—A press telegram from Sioux City, Iowa, says that articles of incorporation of the Electric Railroad Syndicate, of New York, capitalization, $1,000,000, with Stephen H. Emmens and Newton W. Emmens, of New York, directors, was filed there recently. The business is to take and execute contracts for constructing and equipping electric lines.

NEW YORK CITY—The Elm Street Connecting Railway Company, of New York, with a capital of $20,000 has been incorporated. Directors: Charles E. Warren, Sharon Graham, William A. Dibbs, Mark J. Martin, Clifford S. Beattie, Henry L. Jeffries, Andrew J. Loughlin, Lewis H. Thrall, all of New York city, and D. E. Clifford Moorhead, of Jamaica, L. I.

NEW PRAGUE, MINN. — The New Prague Telephone Company has filed papers of incorporation with the secretary of state and paid the fee on a capitalization of $10,000. The new company proposes to operate a telephone system in towns of less than 20,000 through Scott, Le Seuer and Rice counties, with headquarters at New Prague. S. A. Vopatek, J. F. Barta, M. Rybak, all of New Prague, constitute the board of directors.

AMSTERDAM, N. Y.—The Amsterdam & Hagaman Traction Company has been incorporated with a capital of $100,000, to operate a street surface electric road five miles long, from Florida avenue and Broadway road, Amsterdam, to Paulding and William streets, in the village of Hagaman. The directors are: William K. Archbold and Robert R. Reid, of New York; Paul T. Brady, Robert E. Drake and Simon B. Storer, of Syracuse; J. George Kaelber, of Rochester; W. Barlow Dunlap and Louis E. Harrower, of Amsterdam, and William H. Cornell, of Buffalo.

BUSINESS NOTES.

Marinette Iron Works Manufacturing Company, Marinette, Wis., is manufacturing a complete line of the Walrath gas and gasoline engines in sizes from two to 200 horse-power. This engine is guaranteed to make a first-class electric light without the aid of a countershaft or heavy flywheels. It is claimed to be thoroughly made, has an automatic oiling system, and all parts are accessible and interchangeable. The company has a catalogue recently from the press which will be of interest to any one who desires to be intelligently informed on the subject of gas and gasoline engines. The Chicago office of this company is at 301 Fisher Building.

The Eddy Electric Manufacturing Company, Windsor, Ct., has had a particularly large demand during the past few weeks for the Eddy motors and generators known as Type G. These machines are made in sizes from five horse-power to 30 kilowatts inclusive. They are all multipolar construction having a cast-steel magnet formed of octagonal shape with extensions on either side for supporting the pillow-block bearings. These machines are claimed to be electrically and mechanically perfect in construction and the features of commutation, bearings, armature, field-pieces, brush-holders, exciting coils are carried to their highest perfection. This company will send on request a bulletin of its various types of dynamic machinery including motor-generators, rotary transformers and boosters.

The Onondaga Dynamo Company, Syracuse, N. Y., has recently completed some further improvements in the new factory which it occupies, and the establishment now ranks as one of the most complete and well-planned manufacturing plants in the electrical field. The building is so constructed that light is evenly distributed from the glass roof to all the floors, and every facility in the way of mechanical equipment has been installed. On the ground floor the heaviest machine work is carried on. Here a large traveling crane is placed for the movement of heavy machines and for facility in shipment. The floor space is so arranged that trucks may drive directly into the shop under this crane. On the floors above, the various processes in the lighter work in connection with dynamo and motor construction are carried on, such as armature winding and commutator construction. The top floor is entirely given up to the Syracuse Electrical Instrument Company in the making of electric measuring instruments. This company, as is generally known, is affiliated with the Onondaga Dynamo Company. Mr. J. W. Eager, president and manager of these two companies, reports an era of unprecedented activity.

ELECTRICAL PATENTS

[Specially reported for this journal by E. S. Duvall, solicitor of patents, Loan and Trust Building, Washington, D. C. Copies of any patent may be secured for 10 cents each.]

ISSUED MAY 22, 1900.

649,917 Electric shampoo apparatus; H. C. Doersch, Nyack, N. Y.

649,922 Apparatus for electrically lighting lamps; H. C. Farquharson, New York.

649,927 Rheostat; C. Flohr, Coswig, Germany.

649,933 Electric releasing device for shutters; J. Hueston, New York.

649,942 Synchronizer for electric machines; C. J. A. Michalke, Charlottenberg, Germany—Consists of two or more alternating single-phase or multiphase current machines, each having three or more phase-displaced tensions, a responsive device connected between points of the machine having equal tension, and two or more responsive devices connected between points of the machine which subject the same to tensions of displaced phases.

649,950 Battery plate; J. K. Pumpelly, Chicago, Ill.

649,959 Signal for trunk lines of telephone systems; C. E. Scribner, Chicago, Ill.

649,972 Electric-motor-controlling device; T. S. Watson, Milwaukee, Wis.

649,974 Dynamo engine; M. L. Whitfield, Memphis, Tenn.—Consists of a dynamo, a stationary abutment carried by the field-magnet thereof, a low-pressure cylinder, a high-pressure cylinder-piston in said low-pressure cylinder and cooperating with said abutment, and connections with the cylinder-piston for operating the dynamo-armature.

649,976 Electric incandescent lamp; J. Atherton, London, England.

649,989 System of electrical distribution for electric railways; F. R. Koss, Charlottenberg, Germany A main-supply conductor, a plurality of auxiliary supply-conductors connected therewith, and sets of contacts, the number of sets corresponding to the number of auxiliary conductors, the contacts of each set being electrically-connected with one of the auxiliary supply-conductors, and each contact of any set being arranged alternately with the contacts of another set or sets.

649,990 Underground electric-railway system; J. B. Larkin, Pittsburgh, Pa.

649,994 Automatic circuit-closing telegraph-key; L. F. Ritchie, Elwyn, Pa.

(Continued on page 28.)

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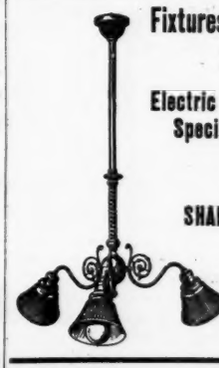

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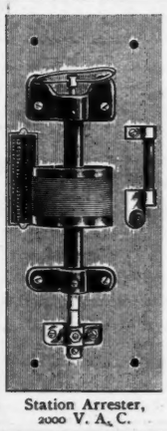

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PATENTS.

(*Concluded from page 27.*)

649,998 Element for storage batteries; E. A. Sperry, Cleveland, Ohio.

650,010 Electric switch; J. B. Heller, Philadelphia, Pa.—Two rotary interrelated electrical switches, independent levers therefor, and means whereby operative connection of each of said levers with its respective switch is dependent upon the positions of the switches themselves.

650,014 Electric motorcycle; Isidor Kitsee, Philadelphia, Pa.—A battery comprising positive and negative electrodes, solid chemical depolarizing material in contact with said negative electrodes, and means for causing said depolarizing material to move over the surface of said negative electrodes.

650,015 Electric welding; E. Lagrange, Brussels, Belgium.

650,030 Apparatus for operating contracts for electric traction; A. Ballance, Hull, England.

650,051 Electroplating apparatus; L. Potthoff, New York, N. Y.

650,057 Controller for electric circuits; A. L. Waters, San Francisco, Cal.

650,062 Thermo-electric pile; L. Gottscho, Charlottenburg, Germany—A heat-retaining diaphragm or wall to enclose the heated joints only and a series of conductors of relatively-small cross-section to connect these with the cold joints.

650,090 Electrical ear-trumpet; F. Macdaniel, New York, N. Y.—Comprises means for creating an artificial sound within the instrument, means for collecting external sounds, and means for transmitting both of said sounds to the ear of the person using the instrument.

650,094 Track and conduit construction for underground electric street-railways; J. H. Robertson, New York, N. Y.

650,096 Recorder for rapid automatic telegraphy; C. F. Rodde, Berlin, Germany—A recording instrument for rapid automatic telegraphy, consisting of means for producing cathode-rays in combination with an electro-magnet adapted to deflect same, and of means for registering such deflections.

650,109 Apparatus employed in wireless telegraphy; Gug. Marconi, London, England—Consists of the primary and secondary of a sparking appliance, a battery and key in circuit with the primary, an aerial conductor connected to one terminal of the secondary, a receiver, means for connecting the said terminal to the receiver, and a capacity connected to the other terminal.

650,110 Apparatus employed in wireless telegraphy; Gug. Marconi, London, England.

650,113 Insulating-coupling; L. McCarthy, Boston, Mass.

650,115 Insulating-coupling for electric-wire conduits; G. W. Prouty, Littleton, Mass.

650,119 Electrical switch; E. J. Wade, London, England.

650,123 Contact device for electric railways; W. M. Brown, Johnstown, Pa.

650,124 Electric metal-working apparatus; C. Coleman, Chicago, Ill.—An electrode between which and a mass of metal an arc is adapted to be formed, a muffle surrounding the electrode and enclosing the arc, and a peep-tube provided with a revolving pane.

650,172 Telegraphic sounder; A. A. Dittmar, Jersey City, N. J.

650,178 Manufacture of filaments for incandescent electric lights; S. B. Husselman, Worcester, Mass.

650,196 Switch for electric motors; G. A. Schoeller, Mulheim-on-the-Ruhr, Germany.

650,219 Storage-cell; F. W. Barhoff, Hartford, Ct.

650,246 Armature for dynamo-electric machines; G. Heidel, St. Louis, Mo.

650,247 Electrode for secondary batteries; F. Heimel, Vienna, Austria-Hungary.

650,255 Space electricity; Isidor Kitsee, Philadelphia, Pa.—A pathfinder, comprising a series of aerial conductors each of which is placed at a different compass-point and having a separate circuit, and a translating device in circuit with each of said conductors.

650,258 Accumulator plate; Wil. Majert, Grunau, Germany.

650,274 Voltaic battery operated with fused materials; W. S. Rawson, London, England.

650,275 Electric-light dimmer; H. E. Reeve, New York, N. Y.

650,358 Fire-alarm telegraph apparatus; W. H. Kirnan, Bayonne, N. J.

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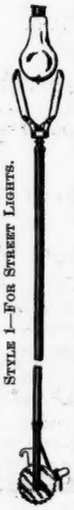

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